POWER PLANT ENGINEERING

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Hospital Plant at Middleton

SMALL STEAM GENERATING AND POWER PLANT FOR INSTITUTION WELL EQUIPPED FOR CONVENIENCE AND ECONOMY. BY R. E. DOCKAM

AT THE recently completed Tuberculosis Hospital at Middleton, Mass., the power, or central plant, challenges the attention of all who visit the institution. Upon superficial examination, the earmarks of good workmanship and mechanical taste appear on every hand, and throughout the plant indications of careful and painstaking thought, demonstrate a comprehensive grasp of present and future needs. A general survey of the plant indicates its purpose of design. It connects with the hospital proper by means of a reinforced concrete tunnel some 380 ft. in length. Through this are carried all pipe lines and wire circuits.

The hospital building some 780 ft. long in one and two-story elevations, is planned to care for 200 patients and has its requisite number of cooking, warming and sterilizing devices located throughout its ample area.

Heating is accomplished by a vacuum system, a pressure of from 1 to 2 lb. per sq. in. being carried in the heating mains and a vacuum in the returns. There are located throughout the plant about 350 radiators having a total of 15,000 sq. ft. Upon the feed end of each radiator is placed a Jenkins modulation valve, while a Thermograde return trap is fitted to each return end.

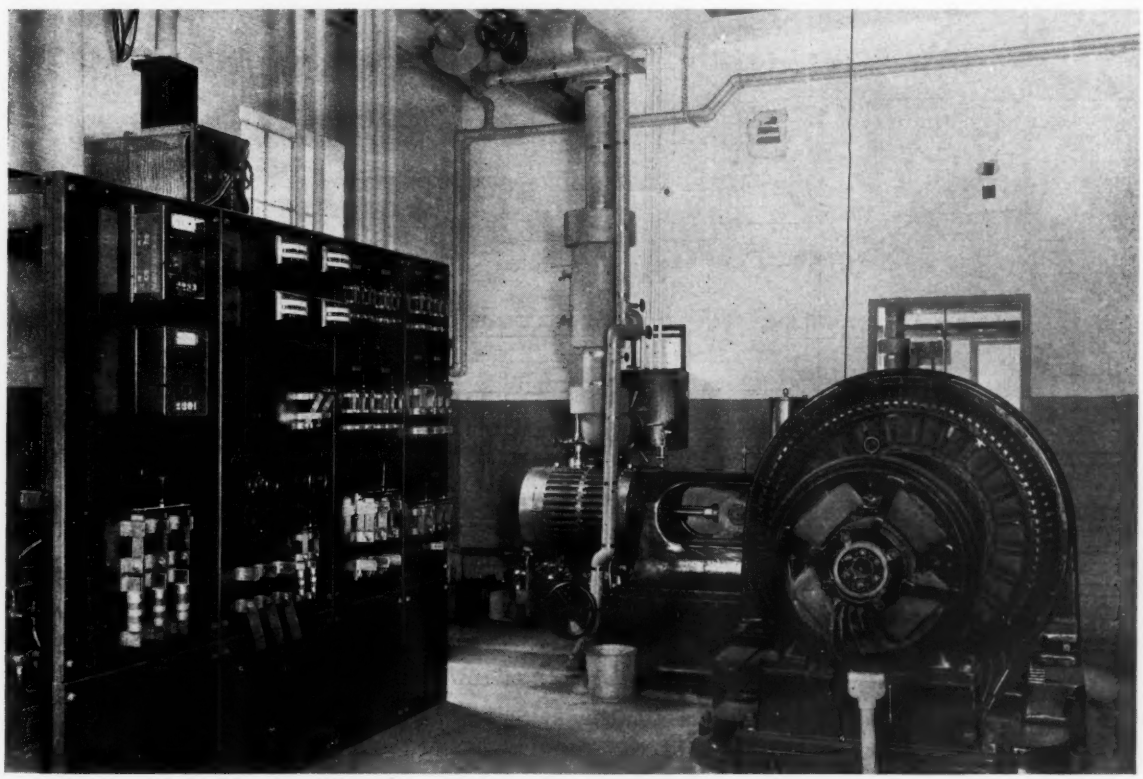


FIG. 1. COMPACT ENGINE ROOM OF MIDDLETON TUBERCULOSIS HOSPITAL

Throughout the hospital plant are placed sterilizing and cooking devices essentially necessary to an institution of this sort, pressure in the steam lines serving these devices is maintained at 30 lb. per sq. in.

The building in which the power plant is housed is a

two-story brick and cement structure with basement; the plant occupies the basement floor; the first floor is devoted to a general steam laundry, while the second floor is occupied by dormitories for the help. Adjoining the central plant are the coal bunkers, roofed over with reinforced concrete, and of generous proportion.

A glance at the chimney of the plant discloses some features of interest, an octagonal shaft 100 ft. in height gracefully designed. Built into its base is found an incinerator. The detailed plan shows a novel construction, of original design. For a distance of 39 ft. from ground level is built an interior core of fire brick, surrounding which is a 2-in. air space between the core and walls of the chimney itself. The significance of this design, as regards protection from overheating and warping of the chimney structure, is plainly apparent.

Steam is supplied to the laundry mentioned above, with its numerous washing machines, driers, pressing machines and mangles, and a nominal pressure of 80 lb. is maintained.

Steam as a driving power is used in the plant in operating only the generator and pumps.

Having thus briefly set forth the purpose of the plant, a more specific consideration of the various units may be indulged in.

Boiler Room

The boilers, three in number, are located in a one-story wing adjoining the central plant building: the wing is provided with a well drained concrete floor. The importance of the placing of boilers in this wing is readily seen, when it is remembered that the floors above

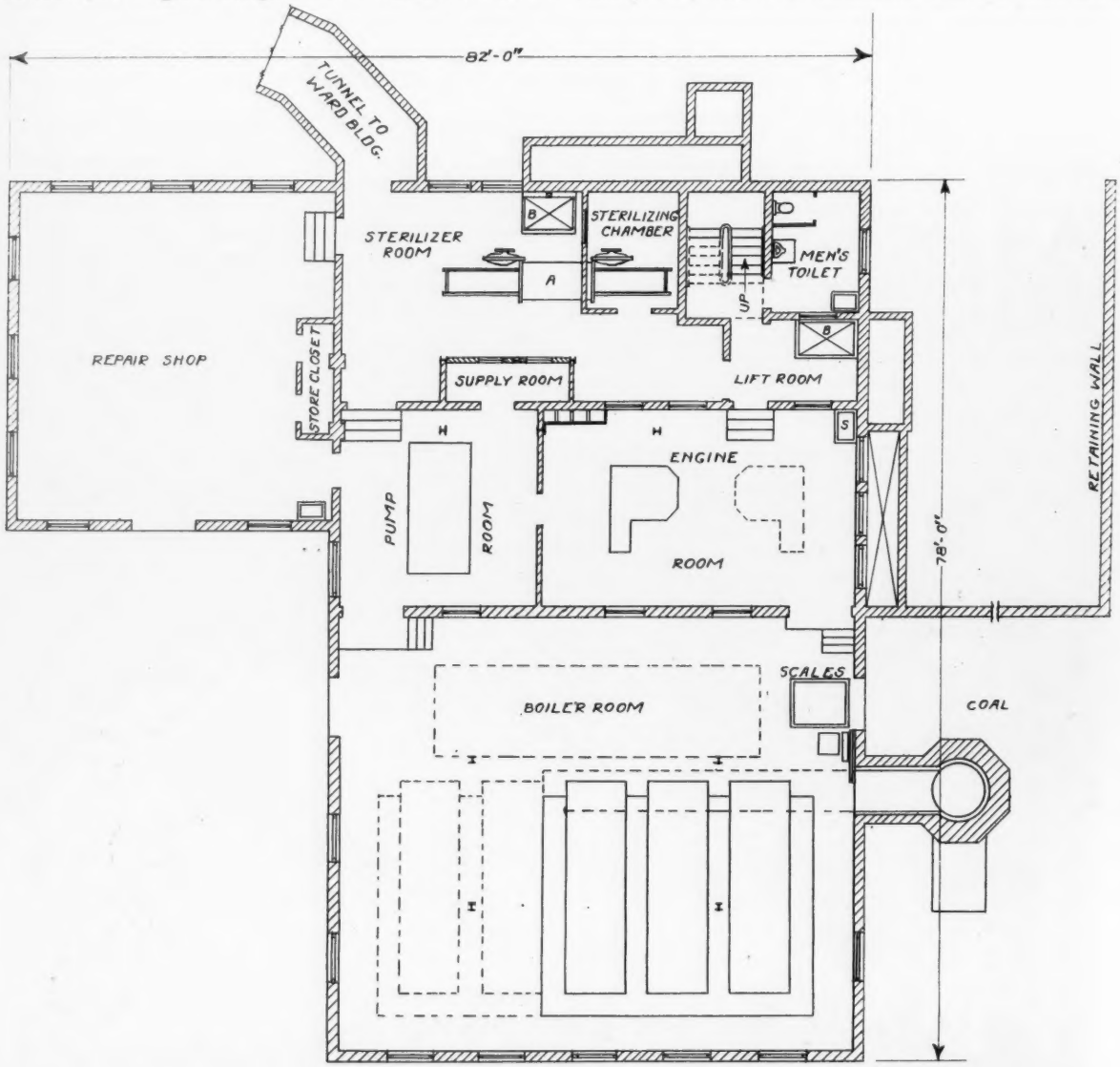


FIG. 2. CONVENIENT PLAN OF POWER PLANT

are in constant use. This arrangement of boilers (in the wing) permits the escape of excess heat, through roof and skylight, into outer air, preventing overheating of the upper stories. The boilers are so placed that two additional units may be installed to meet future requirements. They were built by the New England Iron Works to conform to the Massachusetts standard, made of ⅜-in. open hearth homogeneous fire box steel, and are 17 ft. 4 in. in length by 66 in. diameter.

Each boiler has 98 lap welded charcoal iron tubes

3 in. in diameter by 16 ft. long. Boilers are tested for a permissible working pressure of 100 lb. per sq. in.

Other details of each of the boilers are as follows: Two 11 by 15-in. manholes on top of the shell and one 3½ by 5½-in. handhole in rear head; two 6-in. steam nozzles, one safety valve nozzle, one water connection and one 2-in. blowoff flanged connection; a 2-in. iron sized brass water connection entering front head and running full length of each boiler, across tubes and downward, discharging below tube level; one United States long pattern fusible plug; shaking and dumping grates each having an area of approximately 30 sq. ft.; Reliance cast-iron water columns equipped with high and low water alarm; and 4½-in. Crosby pop safety valve set at 100 lb.

3 mo. period. Scoops, slicing bars, wrenches, tube cleaners, hung in neat array upon the walls complete the equipment of this section.

Pump Room

Boiler feed and vacuum pumps are arranged in duplicate pairs; there is one steam 6 by 4 by 6-in. Blake duplex piston pattern, boiler feed pump fitted for hot water, with cast-iron drip pan and chamber and mechanical oil lubricator. The cylinder drip and pan drip are provided with suitable drain pipe and connected with sewer. Augmenting this device, is one Dayton piston pattern pump, 5-in. cylinder and 6-in. stroke brass fitted. The pump is direct connected to a General Electric Co. a.c. 2-phase, 60-cycle, 220-v. electric motor of about

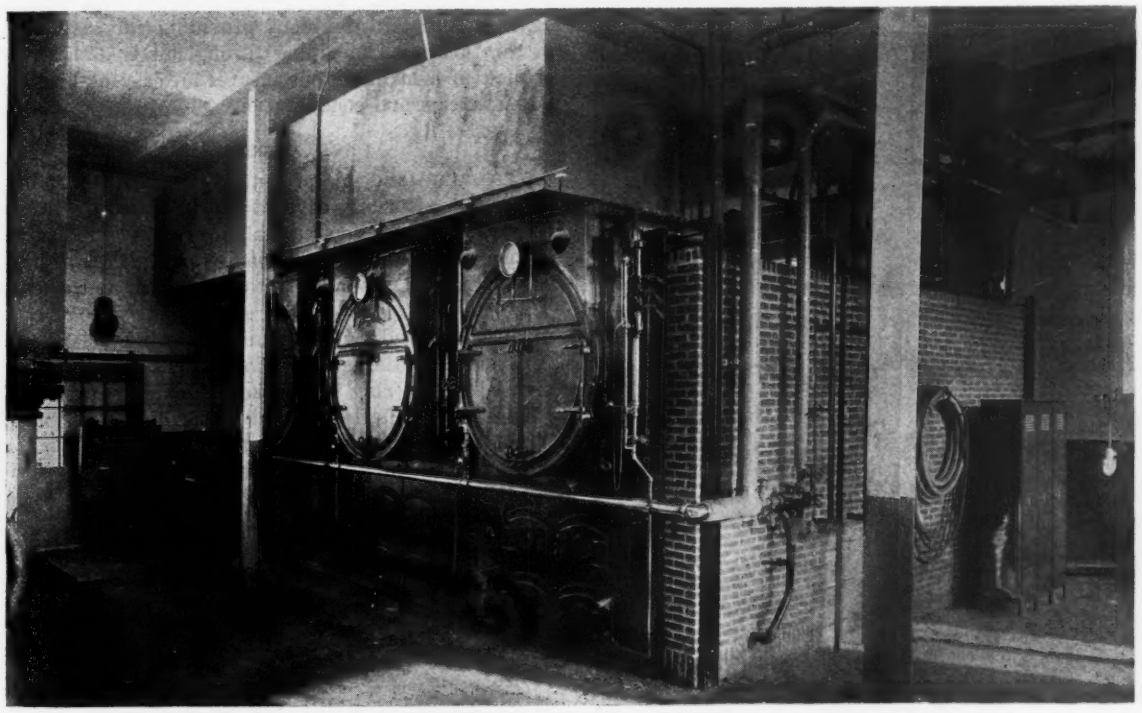


FIG. 3. SUNLIGHT IS AN EVIDENT CHARACTERISTIC OF THIS BOILER ROOM

All piping along front of boilers is of heavy iron sized brass and polished. Under the tri-cocks polished copper funnels fastened to brass drip pipes are installed. Draft control is maintained by means of a Spencer damper regulator.

In the front casing of each boiler is installed a Diamond steam soot blower with pipe connection and hand operated valve.

State police laws of Massachusetts require at least two positive methods of feed water supply, therefore the boilers are equipped in addition to pumps below mentioned, with a Metropolitan injector.

Directly in the path from coal bunkers to boilers is located a set of Fairbanks weighing scales.

It may be worthy of mention that the location of the hospital is such that temporary isolation is possible during winter months, during heavy snow falls. The entire plant is therefore designed to be self maintaining for a

5 hp. through a set of gears, in castings. The motor has a rawhide pinion and cast-iron bed supporting the pump likewise.

Arrangement of the vacuum pumps is as follows: One Dayton 6 by 10 by 12-in. direct acting vacuum pump, brass fitted, with submerged stuffing-box on vacuum cylinder end of the piston rod, fitted with cast-iron drip pan and mechanical oil lubricator. Drip pan and cylinder drips drained as above. The pump is provided with a proper vacuum pump governor and two 6-in. gages for vacuum and pressure made by the U. S. Gage Co. Supplementary to this is installed one electrically driven Dayton vacuum pump brass fitted cylinder, having 12-in. stroke. This is direct connected to an electric motor of about 5 hp. through encased gears; supported as in case of electric feed pump, and fitted with vacuum gage as above. Each vacuum pump is fitted with a flanged cast-iron suction strainer with a removable top and drawoff cock.

Receiving Tank

All water of condensation is returned into a 30 by 66-in. wrought iron receiving tank located in the pump group, the shell being made of ½-in. boiler iron with ⅜-in. heads. It is fitted with an automatic governor of Waters type for steam pump and electric Cutler-Hammer float switch for electric pumps. A ⅝-in. gage glass on front head completes the outfit. This tank serves as a feed water heater, all boiler feed water being passed through it before entering pumps and boiler feed line.

Engine Room

Here, with provisions for one additional, is found one Ridgeway automatic horizontal steam engine, direct connected to a 60-kw. generator. This unit furnishes power for the entire plant, electric light being bought from the town electric lighting company. The engine

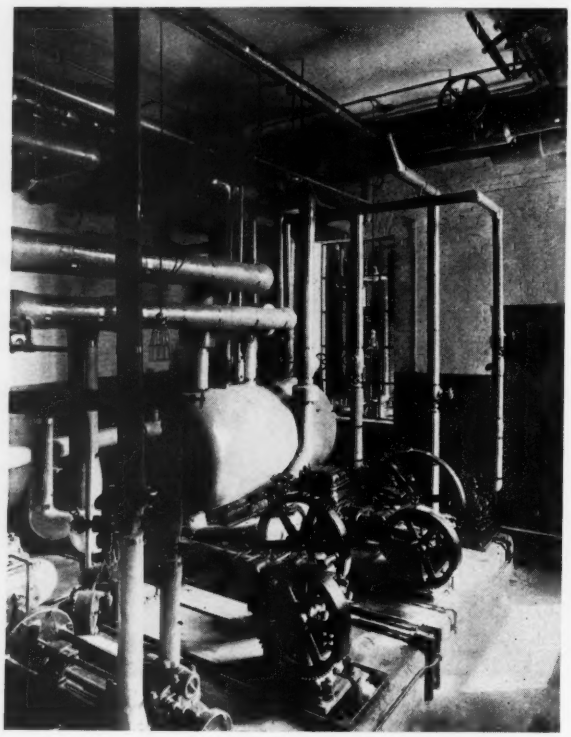


FIG. 4. NEAT PIPING WELL COVERED IS ATTRACTIVE FEATURE OF THIS VIEW OF VACUUM AND FEED PUMPS

runs at 300 r.p.m. and develops 75 hp. with a steam pressure of 80 lb. and a back pressure of 5 lb. The generator is of General Electric Co. make, 60 kw., 240-v., 3-phase, 60-cycle, continuously rated 50 deg. rise, engine type, with connected exciter.

In the steam feed line to the engine a Bundy steam separator is installed, having proper drip pipe and trap connecting with sewer. In the exhaust pipe is a 6-in. Bundy oil separator, fitted with removable baffle plates and gage glass. The separator is provided with a proper grease trap and is connected to the drain pipe. The absence of water about the device is noticeable, drip pipes being provided and connected to throttle and stuffing-boxes. A back pressure and relief valve of the Twentieth Century type is likewise installed in this exhaust line, indicating a load of from 2 to 5 lb.

A glance at the piping layout may be of interest, as in this particular the craftsmanship of the heating contractor (Huey Bros., Boston, Mass.), is evidenced. Steam leaves the boilers through 6-in. pipes bent into long sweep 90-deg. turns, and fitted with gate valves, enter 10-in. headers which traverse the width of the boilers, the low pressure line for heating being fitted with a Twentieth Century reducing valve. Headers are dripped over boilers and the water of condensation returned through Atwood & Morrill traps to receiving tank mentioned above. The system is free from pockets, has perfect alinement and is a delight to one of mechanical training. The material used is of National Tube Co.'s manufacture. All high pressure lines in the boiler house are erected with flanged joints and with extra heavy fittings, low pressure work being of the regular screw pipe construction. Inserted in all screw pipe lines is a generous number of unions providing for easy repairs in the future. The piping throughout is designed and erected in a manner that insures an easy and noiseless flow of steam and condensation.

Covering

The high and low pressure system of piping in the power plant is neatly covered and insulated by means of 85 per cent magnesia sectional covering, secured in place by lacquered bands. Valve bodies are finished with magnesia cement 1 in. thick troweled smooth and canvased. The final finish is one coat of sizing and two coats of best quality lead and oil paint in businesslike colors.

The maintaining of chimney gas temperature is secured by covering the smoke flue exterior with 85 per cent magnesia applied in blocks 1 in. thick, supplemented by a 1-in. coat of magnesia cement troweled smooth and painted as above.

Extreme care was used in the testing of the plant, a temporary blowoff was installed and the entire system was subjected to an excess pressure test covering a period of 10 hr. The system was carefully blown off, removing all scale, grease, etc.

Low pressure feed mains in general were subjected to a 50-lb. pressure test while the return system of concealed piping was subjected to a 50-lb. hydrostatic test. High pressure at 100 lb. was maintained in the power system stated above.

The blowoff for the boilers is of 2-in. extra heavy pipe, and is fitted with extra heavy blowoff cocks and a 2-in. gate valve. Inside the setting all blowoff piping exposed to hot gases is protected by removable cast-iron sleeves. The lines are assembled as shown and extended to a dry well outside of the boiler wing.

The engineering work on this plant was done by the John H. Bickford Co., engineers and architects, of Boston, Mass.

In explaining the manufacture of cement, the Portland Cement Co. says: Last year 7,400,000 T. of coal, 2,340,000 bbl. of fuel oil, and 3,000,000,000 cu. ft. of natural gas were burned in the manufacture of cement in the United States. Each 376-lb. barrel of cement represents an average fuel consumption of 200 lb. of coal, or its equivalent.

The heat required in making cement is about 3000 deg. F., such enormous heat being necessary to fuse limestone and the other ingredients into a 'clinker'."

Mechanical Draft

Its Control, Relation to Heat Transfer, Gas Velocity and Difficulties Experienced in a Specific Installation. By A. W. Binns

BURNING low grade fuel and developing high ratings call for powerful fan equipment. In the installation from which the following data was gathered and on which the tests were run, low speed, axial feed, centrifugal blowers were used.

There was both a forced and induced draft fan, driven through a reduction gear by a Terry turbine, with a motor as an alternative drive. On an average these fans run at 400 r.p.m. The general arrangement is shown in Fig. 1. As will be seen the fans serve Coxe stokers and Stirling boilers. Running at 200 per cent of rated capacity, which rating is not usual, the induced draft fans are called upon to deliver 200,000 lb. of flue gas per hr. The stack merely conducts the gas out of the building and serves only slightly as a draft producing device.

Physical Conditions

Little trouble is experienced with the forced draft equipment. Perhaps the worst trouble has been with the fan blades becoming clogged with dirt. As the fan is fed axially it is difficult to prevent some of the oil from the bearings being drawn in with the air occasionally. Dust in the air then adheres to the blades and chokes up the fan. It is the practice to open the fan housing every time the boiler is down and thoroughly clean the blading.

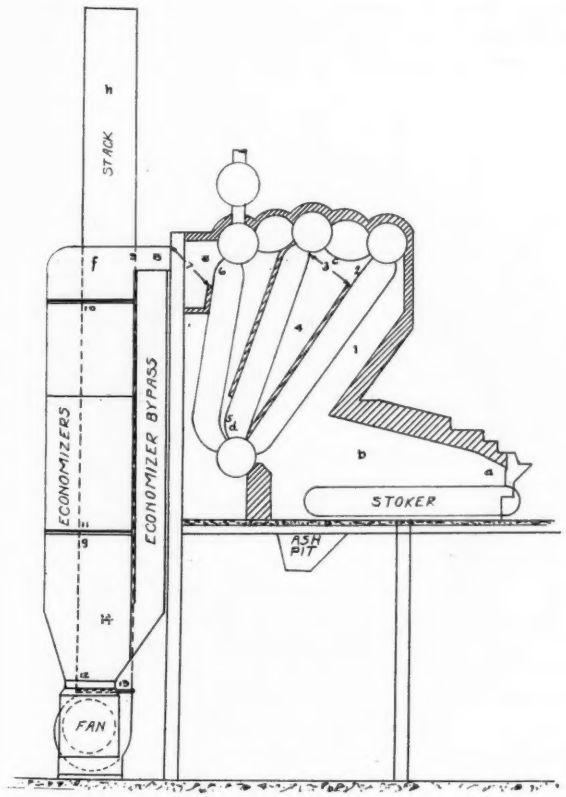


FIG. 1. CROSS SECTION SHOWING GAS PASSAGES THROUGH BOILER SETTING AND ECONOMIZER

With the induced draft fan, however, it is a different story. The gases are drawn through at a high velocity, at times reaching 60 ft. per sec. Suspended in these gases are fine cinders and other earthy material. In all, a splendid sand blast is produced, and the erosion is, as one might expect, very rapid. Every blade in the fan must be renewed once a year, while the fan housing must be patched frequently and sometimes renewed.

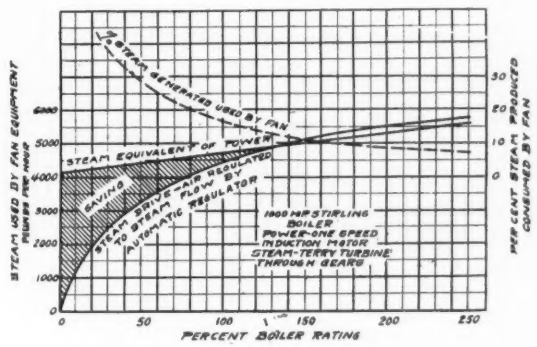

STEAM GENERATED USED BY FAN
STEAM EQUIVALENT OF POWER
SAVING
STEAM SAVED AS REGULATED TO STEAM FLOW BY AUTOMATIC REGULATOR
1000 HP STIRLING BOILER
POWER-ONE SPEED INDUCTION MOTOR
STEAM-TERRY TURBINE THROUGH GEARS
STEAM USED BY FAN EQUIPMENT POUNDS PER HOUR
PER CENT STEAM PRODUCED CONSUMED BY FAN
PERCENT BOILER RATING

FIG. 2. RELATION OF STEAM AND POWER CONSUMED BY FAN EQUIPMENT TO BOILER LOAD

Even the fan spokes are cut away and must be reinforced. This is all part of the price which is paid for economizers, but in the author's opinion it is well worth paying. It should be noted also that when a supply of parts is on hand and mechanics are thoroughly familiar with their work, and the requirements of the case, little real difficulty is experienced.

No trouble of a serious nature developed on the turbine or gears and the control dampers gave satisfaction.

Steam Consumption

The forced draft fan is rated at 31 hp. while the induced draft fan is rated at 49 hp. or a total of 80 hp. This, however, is the manufacturer's rating. Actually from 5 per cent to 15 per cent of the steam produced by the boiler is used by its auxiliaries. When the fans are not steam driven a 100-hp. motor is used.

Reference to curve Fig. 2 will show how the steam consumption varies with the load. It will be seen that when the fan is motor driven, that is when the fan speed does not vary with the boiler load, there is little difference in the power consumption along the rating scale. By steam equivalent is meant simply the steam which is used to make the power which is used by the fan motor. It will also be seen that when the fans are turbine driven and when the turbine speed is varied with the air requirement, a considerable saving is effected. This is represented by the shaded area. In practice this saving amounts to 10 per cent of the steam consumption of the fan or about 1 per cent of the steam output of the boiler.

It should also be noted that the steam control and

CO_2 control are somewhat better because, owing to damper leakage, regulation is not altogether positive. This also points strongly to the fact that the auxiliary steam consumption per unit of boiler output decreases as the load increases. This appears to be another reason for higher ratings. This is especially true where economizers are installed and owing to the compensating action of the economizer, the total stack loss remains constant, or very nearly so, along the rating scale.

The exhaust from the fan turbines is condensed in the feed water heater. Thus most of the heat to the fan drive is reclaimed.

Actually, under average operating conditions, only 1.6 per cent of the heat in the coal is lost to the auxiliary

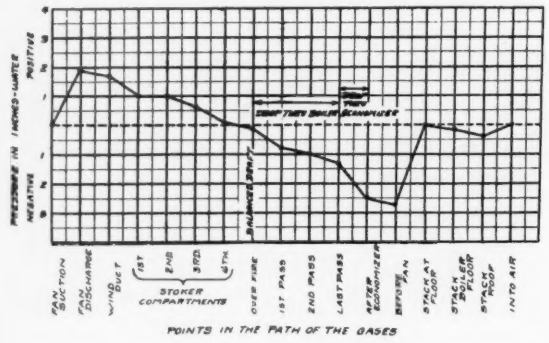


FIG. 3. DRAFT DROPS THROUGH BOILER SETTING

equipment. This of course only debits the turbines with the actual heat taken out of the steam by them and credits them with the heat which is reclaimed in the heater.

Thus while the steam consumption appears high, when the exhaust from the units is used to preheat boiler feed water and the boiler is operated around 200

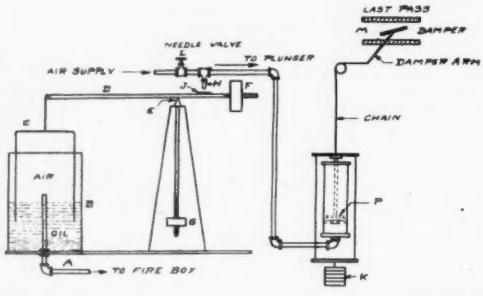


FIG. 4. DIAGRAM OF DRAFT CONTROL DEVICE

per cent rating, that consumption reduces to a reasonable amount. If, in addition to this a variable speed is used, the loss is still further reduced.

Average Draft Conditions

The average draft drop through the boiler setting is best shown by Fig. 3. Reference may be had to Fig. 1 to see the points through the setting at which the drafts are taken. At four points during its journey through the boiler setting the gas comes to the atmospheric pressure line.

It is drawn from the atmosphere, put under pressure by the forced draft fan and forced through the fire bed. In the fire box, with the balanced draft condition, it crosses the atmospheric line as the action to the induced draft fan is felt. Again it touches the line just past the induced draft fan. From here nature lifts it out of the stack and for the fourth time it reaches the atmospheric line. Thus it returns to the air whence it came at the same pressure but in a far different state.

The curve, Fig. 3, is the result of nearly 500 tests regularly taken and represents average conditions.

Draft Control

Owing to the high draft intensities and the fine and variable coal used, considerable difficulty was experienced in keeping the correct draft condition in the fire box. An apparatus was finally developed by the operating force. It is interesting to note that this home-made apparatus has been in successful operation for a considerable period of time.

The draft control machine installed on each boiler is designed to operate automatically the last pass damper and thus effect a closer regulation than would otherwise be possible.

The ideal draft condition over the fire is from 0.05 to 0.10 in. of water suction. This condition is desirable, because first, it prevents a back, or positive pressure which would tend to overheat and melt down the ignition arch; and, second, it prevents excess vacuum over

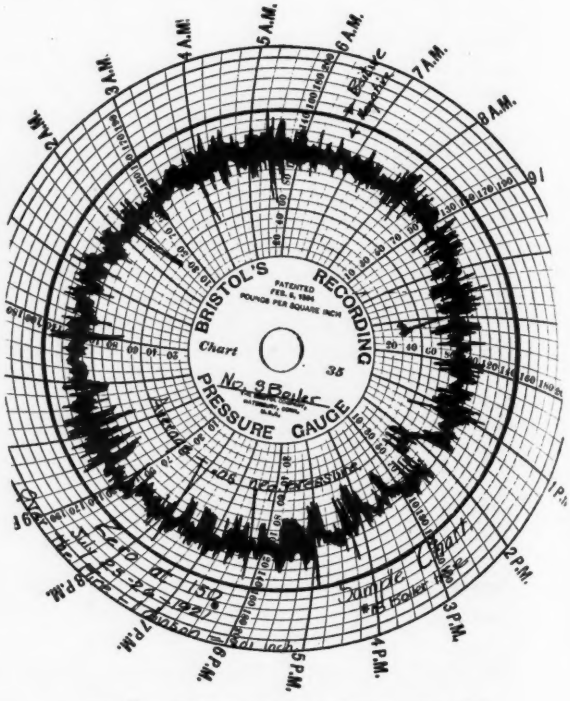


FIG. 5. RECORD OF DRAFT OVER FUEL BED

the fire. High vacuum has a tendency to pull cold air in through the settings and also tends to create holes in the fire.

The diagram, Fig. 4, shows the method of automatic operation. The draft over the fire is led through the ½-in. pipe A to a tin can, B, filled with oil. Inverted in

this can is a second tin can C which is actuated by the draft from the fire box.

Supporting can C is a lever resting on knife edges at E and having on the other end a counter weight F and also a vertically suspended weight G.

As the fire box pressure, for example, goes from —0.10 to —0.03 the force holding down the can C is decreased, and the counter weight F overcomes the air suction within can C, raising it, while the weight F descends, thus removing the seat J from the nipple H and allowing the air pressure to exhaust through the port instead of going to the plunger. This allows the counter weight on the plunger, K, to pull down the damper chain, opening the damper M. When the damper is opened the air flow through the boiler is increased with the result that the fire box draft comes back to —0.05 or —0.07 in., where it should be. In this way the damper hunts and finally finds its proper adjustment.

Following are instruction for making adjustments:

First. See that the air supply to the machine is turned on and supplied through the reducing valve at a pressure of 24 lb. per sq. in.

Second. See that the plunger is not stuck. If it is all the way down or all the way up it may be in trouble.

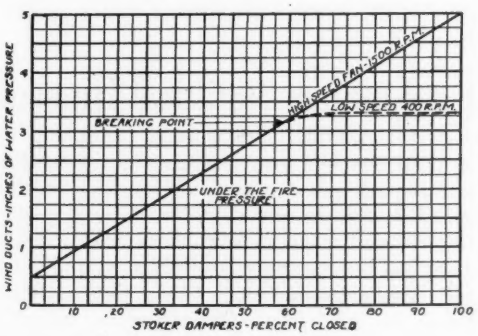


FIG. 6. FAN PERFORMANCE CURVE SHOWING EFFECT OF CLOSING DAMPERS ON HIGH AND LOW SPEED FANS

On the plunger is a cup leather, P, which, when it is all the way down, tends to draw up and the air will pass by it and escape, thus not lifting the plunger. Lift the plunger up and drop it. This will open out the cup leather and the machine will then operate. If the plunger is halfway up it is all right.

Third. If the machine carries a back draft see that needle valve L is choked down to about two turns. If it still carries a back draft move weight F back away from seat, J, making the force tending to lift the can greater.

Fourth. If a high negative pressure is carried, see that the cup leather in the cylinder or the plunger is not leaking badly. Open up a little on the needle valve L. If this does not get the desired results, move weight F nearer to the knife edges.

Fifth. Check operation daily and inspect the plunger, oil if necessary, see that the level D fits properly on the knife edges E and that the plunger chain is all right.

Sixth. Check up the Hays differential draft gage. Turn off the cock and let it settle to zero, to be sure your gage is right.

Seventh. Report promptly any trouble with the apparatus.

Figure 5 is a chart taken from the recording draft gage and shows the pressure over the fire which is maintained by the draft regulator. On this chart one division equals 0.01 in. of water towards the center, below 150 indicates negative pressure, above 150 indicates positive pressure.

Reference to Fig. 1 will show the location of the various draft control dampers which are used. Within limits, the blast intensity of pressure will vary directly as the fan speed and inversely with the opening of the stoker dampers. Figure 6 is plotted from observed

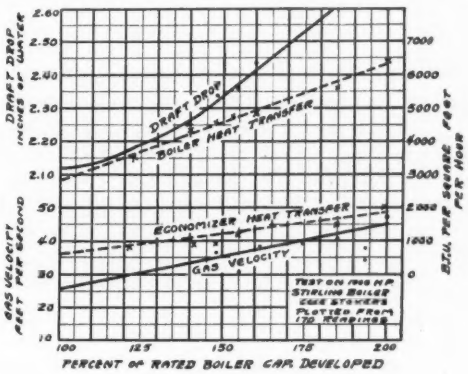

DRAFT DROP INCHES OF WATER
GAS VELOCITY FEET PER SECOND
B.T.U. PER SQUARE FOOT PER HOUR
DRAFT DROP
BOILER HEAT TRANSFER
ECONOMIZER HEAT TRANSFER
GAS VELOCITY
TEST ON 1905 H.P. STIRLING BOILER COKE STOKERS PLOTTED FROM 170 READINGS
PERCENT OF RATED BOILER CAP. DEVELOPED

FIG. 7. RELATION OF DRAFT, HEAT TRANSFER AND GAS VELOCITY TO BOILER RATING

values. It is here interesting to note the difference between the action of the high and low speed fans.

Relation of Draft to Boiler Performance

In the curves in Fig 7 are shown the apparent relations which exist between the draft drop through the boiler, the heat transfer per square foot and the velocity of the gases as observed along the load curve.

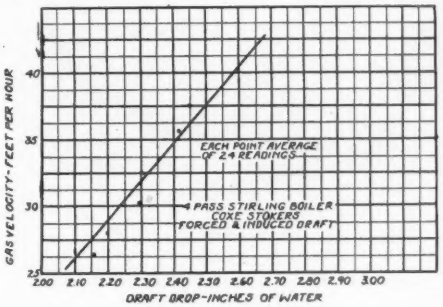

GAS VELOCITY-FEET PER HOUR
EACH POINT AVERAGE OF 24 READINGS
4 PASS STIRLING BOILER COKE STOKERS FORCED & INDUCED DRAFT
DRAFT DROP-INCHES OF WATER

FIG. 8. RELATION OF DRAFT DROP TO GAS VELOCITY IN BOILER SETTING UNDER OBSERVATION

In Fig. 8 the relation between draft drop through the boiler and gas velocity in the particular setting under observation is given. It is interesting to note that the points fall almost along a straight line.

In Fig. 9 is shown the relation between gas velocity and boiler efficiency. This relation is the result of the observations taken on a considerable number of tests which seem to check each other. The other variables influencing efficiency were in so far as possible held constant.

Fan Characteristics

Strangely enough it seems that two different fans, although apparently exactly alike in construction, will

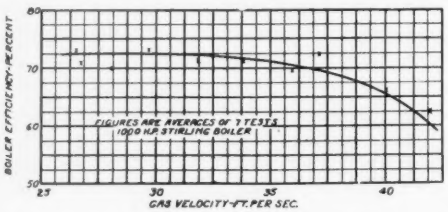


FIG. 9. RELATION OF GAS VELOCITY TO BOILER EFFICIENCY AS SHOWN BY TESTS

have different pressure characteristics. A recording draft pressure gage was connected to the discharge of each fan at the same relative points. A 24-hr. chart was taken on each and in every case a different type of curve was obtained. The same firing conditions were maintained and the dampers were not altered. It was not evident what the cause of the variation was. It was true that in general better conditions maintained on those boilers having the least variation in pressure.

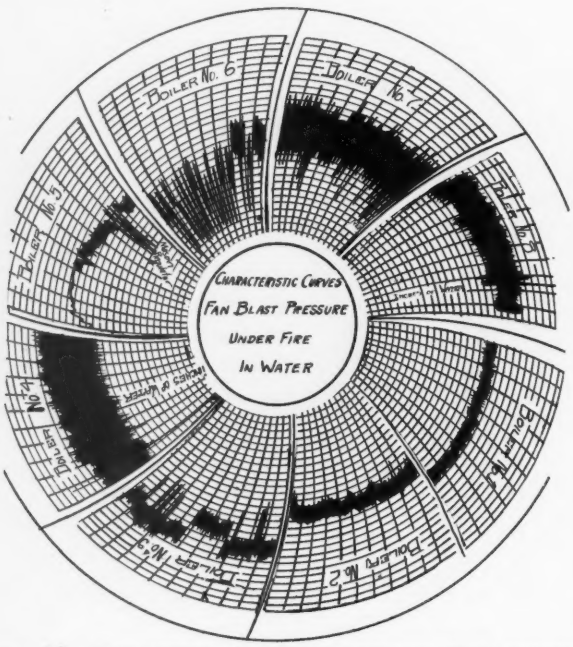


FIG. 10. COMPARISON OF PRESSURE RECORDS FROM FORCED DRAFT FANS

Figure 10 is made up of segments taken on the separate boilers as indicated.

Maintenance

While the laws governing air flow and the relations which exist between draft and boiler losses, may be rather deep, these losses can be reduced to an irreducible minimum by a few simple common sense expedients.

First of all tight settings are essential. Tight settings are difficult to obtain and more difficult to maintain. A good plastic cement over the settings is a great help. An excellent thing to do is to close the last pass damper and throw into the fire box some tar or oily rags or something else that will smoke. One will be amazed at the vast volume of smoke that will pour through the many cracks in the supposedly tight setting.

In traveling grate stokers using fine coal and having high gas velocities, difficulty is likely to be experienced with fine particles of coal being carried into the ash pit. To reduce this loss it is merely necessary to reduce the gas velocities to as low a point as possible and still carry the load. That is, at low rating the velocities of the gases may be low enough to eliminate loss to the ash pit due to the rain of incandescent carbon. At higher ratings, however, this will not be possible and it will be necessary to determine how far the loss to the ash pit may go to obtain rating and altogether the most efficient load point. The most efficient load point, all factors considered, seems to be around 150 per cent.

The completeness and efficiency of combustion depend of course upon the air supply and the air supply in turn depends upon the draft differentials. It is therefore simply a matter of taking an Orsat and analyzing flue gas until the best drafts are found and the damper settings obtained, which will maintain those drafts.

In all, the important thing is to approach the matter in a common sense manner and if the methods employed in this little article are of value in suggesting methods of approach the object of the work will have been accomplished.

Establishing Statistical Bureaus

To encourage more general study and use of essential business statistics, the Fabricated Production Department of the Chamber of Commerce of the United States has announced a service for chamber of commerce and trade associations to give information how statistical bureaus may be established and operated.

Lack of accurate figures on production, consumption and stocks on hand is cited as the prime cause of the runaway markets of the last period of inflation which resulted in excessive prices, overordering, later cancellation of orders and business demoralization. Trade associations have been urged by the Secretary of Commerce to arrange to furnish him figures on matters vital to their industries, such as production, shipments, stocks on hand, etc., but comparatively few are doing it. By failure to assist in this work, whether due to unwarranted fear of possible aid to competitors, or to plain laziness, business men deprive themselves of information of great value in control of their affairs.

Business travels in cycles, an ebb and flow, and managers having and using dependable statistics as a guide can follow a course which will avoid much of the loss and unemployment occurring during depressions.

The effort now planned is not to operate a statistical department, but to encourage trade associations and chambers of commerce to make such departments part of their activities and to assist them to co-operate with the Department of Commerce for the good of their industries and of business as a whole. The United States Chamber of Commerce will gather and hold available information as to how such departments may be set up and operated to secure the desired results.

Don't blame nature when you "fall down."

Steam Turbine Lubrication and Operation---II

EFFECTS OF TEMPERATURE, WATER IN SYSTEM, CARE AND TREATMENT OF OIL. BY THOMAS A. BROWN

THE QUESTION of how high a temperature the oil discharge from the bearings of steam turbines should be is one that is discussed at any time the lubrication of large turbines is brought up. There are many opinions on this, some engineers arguing that a high temperature, 150 to 165 deg. F., is preferable. Others argue for a much lower temperature.

The opinion of the writer is that the lowest temperature possible to obtain is certainly preferable.

This temperature is, in the majority of cases, beyond the control of the operator to bring it below a certain figure. It can be raised, of course, by reducing the flow of water through the cooler, which procedure appears to be foolhardy if the long life of the oil is to be given any

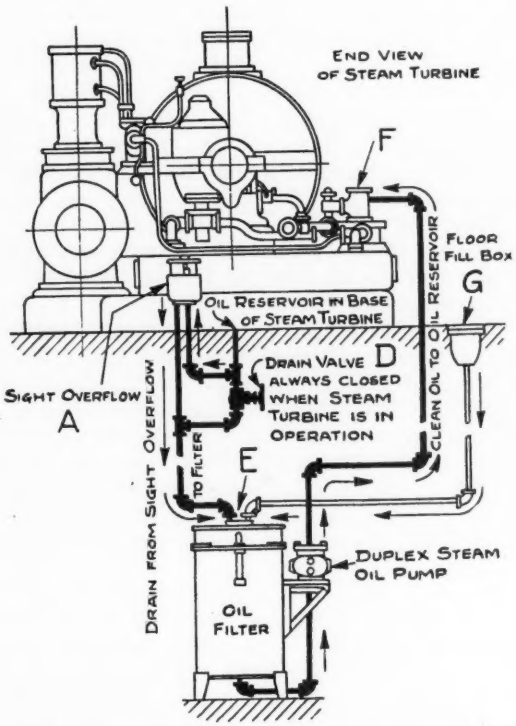


DIAGRAM OF CONNECTIONS FOR THE CONTINUOUS BYPASS SYSTEM OF OIL PURIFICATION

consideration, which long life of the oil will be best served by keeping such temperatures below 125 deg. F.

A specific instance of this is a 10,000-kw. General Electric turbine operating 85 per cent of the time for 5 yr. on the original batch of oil, during which time there was added 550 gal. as make-up, a little being added each month. The highest temperature of oil discharging from the bearings was about 125 deg. F. It is, of course, unreasonable to ask that oil discharge from the bearings be lower or anywhere near the temperature of the oil going to the bearings. This difference between incoming and outgoing oil is usually 25 to 45 deg. F. The quoting of maximum discharge temperature without a statement of incoming temperature is of no value.

Another point seldom thought of in connection with temperature is that if the oil in passing rapidly through the bearing is heated to 150 to 170 deg. F., what must the temperature of the shaft be? And suppose this shaft is 40 to 50 deg. F. higher than the oil—and this is a conservative estimate—think of the very severe temperature that the oil comes in contact with. This temperature of 200 to 220 deg. F. is high enough to make a chemical change in the oil; even though it is subjected to such a temperature for a fraction of a second, it occurs quite frequently. For, as mentioned previously, the period of circulation is from 2 to 5 min. We must not lose sight of the fact that petroleum is a complex mixture of hydro-carbons, the relation of which can be changed when it is subjected to temperatures that are high enough.

Some engineers have put forward the theory that the alternate heating and cooling of the oil is a cause of its finally losing its value. In an experience of over 10 yr., the writer has never found any support of such a fact. There has been found a great mass of evidence that heat does, but nothing with reference to the fact that rapid cooling of an oil changes it chemically.

As mentioned in the previous article in the discussion of the first class of turbines, the high temperature plus rapid circulation will rapidly cause oxidation of the oil, that is, if the temperature is high enough. Also, the rapidity with which this occurs increases with each degree increase of temperature. This oxidation is manifest in the accumulation of a brown friable substance that will settle out of the oil if it is given a rest, or where there is a quantity of oil at rest in some locality in the system.

An analysis of this sediment shows the following:

Soluble in petroleum ether	29.7 per cent
Insoluble in petroleum ether but soluble in benzol	66.9 per cent
Insoluble in both (by difference)	3.4 per cent
	100.0 per cent
Loss at 100 deg. C. for 1 hr	10.0 per cent
Volatile	74.7 per cent
Carbon	11.9 per cent
Ash	3.4 per cent
	100.0 per cent

Also, a sample of sludge shows the following:

Oil	67.0 per cent by volume
Water	4.0 per cent by volume
Muck (finely divided)	24.0 per cent
Muck (coarse)	5.0 per cent
	100.0 per cent

The distinction between the fine and coarse muck was that the fine muck was largely organic, evidently with some metallic elements combined with organic acids from the oil, while the coarse muck was largely mineral matter, mostly iron oxide and siliceous matter.

There is no petroleum lubricant manufactured that will not throw down such sediment when subjected to the severe service in a pressure circulation system of a turbine and where the temperature is high. The accumulation of such sediment is dependent, in a large measure, on the quality of the oil used. With low grade turbine oils, this sediment will collect very rapidly, and its accumulation will also increase with each degree rise in temperature above 125 deg. F. Even with the very highest type of oil possible to obtain, some small quantities of this sediment will be found where the temperatures are high.

This same sediment will be found in larger quantities where there is a steam leak through the packing at the high pressure end which finds its way directly into the No. 1 bearing. As this steam is usually of a very high temperature in modern utility plants, this extreme temperature coupled with the fact that the steam condenses in the pedestal of the bearing and accumulates in the form of water, is a very dangerous condition, as the brown sediment forms a first class emulsifier of the turbine oil if water is permitted to collect in the system. The insertion of a baffle either revolving with the shaft or permanent and fitted close into the shaft will stop this leakage of steam into the lubricating system.

Water in the System

The finding of water in the system is a danger signal. There are several ways of expelling the water that collects in the system, such as a filtering system, water legs, etc., but why not get at the source of the water supply? This may be through a steam leak such as mentioned above, in which case the remedy has already been suggested. Or it may be from the cooler leaking water into the oil. The remedy here is to raise the oil pressure above the water pressure. While this means oil wastage, it is preferable to water getting into the system.

Another point where water may get in is in the case of water cooled bearings and a leaky connection through the pedestal into the bearing shell. This can be checked with the turbine shut down and the cooling water on. Any leakage can be detected by examining the opening in the oil charge line. The only remedy is obvious. Make a good connection.

Another source of water is the sweating of the reservoir. This is one seldom thought of and it can easily be verified by lifting the cover of the reservoir and noting the quantity of condensed water on the inside. The remedy in this instance is ventilation, and in this way equalize internal and external temperatures or nearly so, at least enough to prevent the condensation of water vapor on the cooler reservoir walls.

In the case of some turbine designs where water seals are employed, these at times scale up due to the use of raw water. This scale sometimes attacks the blades of the seal and causes leakage of water. This is of rare occurrence, however. It is seldom that any water collects in turbine oil systems where water sealed glands are used.

Care and Treatment of the Oil

In turbine lubrication as in all operation of all machinery, the care and attention paid to the treatment of the oil is most important.

The filling of the oil system with oil is only a start. Consider the points of temperature, period of circulation, possible water contamination and it will be readily understood that the oil will not last indefinitely.

Also, in order to secure the maximum results from the oil, it should be thoroughly cleaned and separated from all foreign matter or substance that is other than oil. Such separation can only take place in a small way in the system while the machine is in operation because nearly all the oil is in agitation.

There are bypass and treating systems being marketed today to "bleed" a small quantity of oil constantly. In this system, a diagram of which is shown herewith, a small quantity is passed through a filter which removes all water, sediment, etc. Such a system is a real improvement over using the oil without any attempt at purification, and its use adds to the life of the oil.

The oil should be passed through the bypass system slowly, as therein will the full benefit be secured. When the movement of the oil is slight, there is, of course, greater opportunity for the impurities to settle out.

Many engineers use a settling method of purification without a bypass or filter at all. This arrangement is the alternate use of a batch of turbine oil every 30 days. No other treatment except the passing of the oil through a fine mesh cloth when it is drawn from the turbine. After 30 days settling in a tank, the oil is replaced and used again.

With such practice it is well to drain the system immediately after the turbine is shut down. Nothing can settle in the oil reservoir then which would later require cleaning.

Previous mention has been made of a brown friable sediment found in all turbine systems. This material is really the product of oxidation of the oil and it will be found that this sediment is more easily filtered or settled with the oil at low temperatures. At higher temperatures, the sediment or "flock" goes into solution with the oil. When such is the case and water leakage into the system takes place there is every possibility of the formation of a serious emulsion because of the presence of this emulsifier.

This same sediment is sometimes caused by the addition of large quantities of fresh oil to the system. Experiments have been made which show that with the addition of over 15 per cent of new oil to used oil, there will be thrown down such deposits. These deposits increase with the addition of percentage up to about 60 per cent. From this point on, the quantity of sediment decreases rapidly. Therefore, a very safe method would be the addition of no more than 10 per cent of new oil at any one time.

Briefly summarizing the foregoing, it is apparent that any improvement in the handling and treatment of the turbine oil will result in its having longer life.

Importance of Correct Lubrication

There is one factor of prime importance that is seldom considered in connection with turbine lubrication. These large machines, running up in cost to almost $1,000,000 represent quite an investment. Any interruption of service attributable to the kind and quality of the oil used will equal a loss of at least $150 a day as interest on the money invested in one of the large units. This does not include what profit may be made on the

output of the machine. No estimate of which loss can be given.

This question of turbine lubrication was given considerable attention by the National Electric Light Association during the past 2 yr. This association is made up of public utility plant employes, the various companies being members also. There are associate members also, but all are in some way linked with public utility plants for supplying electricity.

They have, each year, a committee on prime movers, which committee during the past 2 yr., appointed a subcommittee on the lubrication of large turbines, its purpose being the solving of the turbine lubrication problem. Also, with the idea of standardizing the kind of oil used.

In this report on the lubrication of turbines, an endeavor is made to base the selection of a turbine oil on physical characteristics, such as gravity, pour test, flash, fire, viscosity, emulsion test, acidity, etc. These physical characteristics are used in the refineries where lubricating oil is made to check the uniformity of the product. But in addition to this the process or method of manufacture is the same for each class of oil manufactured. Also, the kind of crude oil used is known by the manufacturer. So with the physical characteristics, the method of manufacture and the kind of crude oil used, we have the factors that influence its quality. Any attempt to set down a specification which does not include these three factors will lead nowhere.

Lubrication engineering has not yet developed to the point where an analysis of an oil previous to use will show what the results will be in terms of correct lubrication. In this discussion of turbine oil, for instance, there is no laboratory test that indicates how rapidly an oil will oxidize when subjected to the conditions found in the circulation system of the modern horizontal steam turbine. The only way of proving the quality of an oil is by trying it on the machine or unit that it is to be used on. Of course, there are limits which govern this selection. For instance, it is well known that oils can be given certain treatment that will cause them to separate more readily from water, also better resist the emulsifying conditions found in practice.

It would be incorrect to use any oils that had not been given such treatment. Also, it is known that certain types of oil meet these conditions far better than others. Even with an oil that possesses all these superior qualities, there is considerable difference of opinion as to how heavy or what the viscosity of the oil should be.

It is customary, on horizontal turbines, to use an oil with a viscosity of 135 to 160 sec. Saybolt at 100 deg. F. It is known that an oil of much lighter viscosity has, in each instance where used, also given excellent results.

The only argument against such an oil is that because of its very light body it would not furnish an unbroken oil film under the conditions of bearing pressure and temperature.

It is known that all modern horizontal turbines are equipped with a pressure circulating system which furnishes oil at 3 to 15 lb. pressure and in large volume. It is inconceivable that with the quantity furnished there would be any but a perfect oil film, and, in fact, it is believed that the shaft is really "floated."

He who treats his oil the best will receive his reward in terms of longest life of the oil used.

Relation of Chief Engineer to Accident Prevention*

PREVENTION OF ACCIDENTS A CONTRIBUTING FACTOR TOWARDS THE REDUCTION OF COSTS. BY J. H. EUSTACE

THE OPERATING engineer by the proper use of material, methods and labor strives to produce a finished product with a minimum of cost. The successful operating engineer is never entirely satisfied with his results. If the costs of production are high, he must reduce them, or if low, he strives to make them lower. His ambition is to produce a better product at a less cost than his competitor.

In the close analysis of costs, continued efforts are made to obtain materials of the best quality at as low a price as possible; methods are studied to the end that they may be improved and time studies are made in order that workmen may perform their duties in the shortest possible time and in the most efficient manner. All of these are necessary and as they should be for they all are steps towards the elimination of waste in industry.

In this saving of waste, good materials at low cost price and improved and efficient methods very obviously play a most important part and these two elements are very generally appreciated by operating engineers. The third essential, namely, the continued, uninterrupted and safe employment of labor with maximum of efficiency and output, and the saving of direct and indirect accident costs is not, however, always thoroughly recognized by the operating engineer. Nor does he always give the same close attention to accident prevention as he does to the selection of material and the development of economic methods. Whenever an engineer overlooks the waste caused by accidents as an element of his operating problems, he is losing sight of a most important source of waste and failing to recognize a chance for business-like economy in the cost of production.

Here is an opportunity for the engineer to render a great national service. What better service can any citizen perform than that of conserving our resources and at the same time save human lives and preserve the happiness of the American workingman and his family?

That the effort of the engineer to minimize accidents is well worth while may be illustrated by the fact that for the period of 1912 to 1920 the Safety Division of the Industrial Commission of Ohio accounts for a minimum total of $80,000,000 for the medical and compensation cost of industrial accidents. This does not by any means measure the total cost of industrial accidents in the state of Ohio, for to this amount should be added the loss to the workers in wages over and above the amount of compensation received (which would add from $40,000,000 to $50,000,000). If this enormous loss is for one state only what must it be for the whole nation? Statistics further show that there are 80,000 accidental deaths annually in this country of which 75 per cent are preventable.

CHIEF ENGINEER MUST TAKE ACTIVE INTEREST IN SAFETY WORK

IN THESE days, after our years of experience have proved that organized and careful plans for safety in

*Abstract of a paper delivered at the Eleventh Annual Safety Congress of the National Safety Council, Detroit, Aug. 28-Sept. 1, 1922.

the operation of our properties give returns of such great value, there are few business executives and few heads of departments who are unconvinced that safety is not only good business but also a great opportunity for doing good as citizens and contributing to the welfare of our great nation. How many executives, however, back up this conviction with the same active interest that they give to their other industrial activities? There are many duties, particularly matters of detail, which may be properly delegated by the chief engineer to his assistants. There are, however, matters of policy which never can be delegated, but which must constantly receive the interest of the chief engineer and without his continual attention such policies are apt to become a dead letter so far as the operating organization within the plant proper is concerned, and of these duties accident prevention is a good example.

Probably the most important step in safety in any organization, large or small, is that of education. The workmen must be taught to think safety and to act safety in their work and should be encouraged to report unsafe practices and to make suggestions toward the prevention of accidents. The man on the job is, after all, in the best position to judge unsafe conditions and practices, and if he is taught to think safety and encouraged to make suggestions for accident prevention he not only becomes a booster for safety, but feels that he is something more than a cog in the machinery and becomes a more efficient workman.

Education of the foreigner is another important factor in accident prevention. Not only does it lessen the liability of accidents to himself and his associates but it assists in the Americanization of aliens, which is another of our present-day industrial problems. It is difficult for workmen who have no knowledge of English to understand orders given by the foreman or read printed instructions and therefore they are more subject to the risks of their occupation than are others favored by an understanding of our language.

No plan for the prevention of accidents is complete unless it provides for our careful attention to practices and methods. The operating engineer should give the same consideration to practices and methods which have a bearing on the safety of employes as he does to other operating methods having to do with efficiency or economy. When plans for a new building or new installation are presented, he should always review them from the viewpoint of safety. He should take cognizance of safety in all plans of construction or installation, for in doing so he not only assures safer operation but he may effect considerable economy by providing physical safeguards in the plans and first construction and by avoiding the necessity of making structural changes after the structure has been built or the installation made. An instance may be cited where recently a plant was badly damaged and some of the employes were seriously injured by the explosion of a compressor which was within the main plant. It was necessary to rebuild the plant and, profiting by the experience of the explosion, the compressor was installed in a separate enclosure outside the main building. Recently the newly installed compressor exploded and on this last occasion the damage was very slight, because it did not affect the main building and only damaged the enclosure in which it was located.

Fire Hazards May Be Avoided

In construction and in operation many fire hazards may be avoided by a serious consideration of fire-prevention measures. This not only guards against the likelihood of fire damages but results in a saving of insurance premiums. Too often changes are recommended by a representative of the fire insurance company after buildings are completed or after repairs are made which either must be carried out at considerable expense or, if left undone, will result in higher insurance costs. Such developments are not uncommon in many otherwise wisely managed concerns.

Let us not be misled in believing that accident prevention does not pay. It does and pays handsomely, just how much can never be estimated in dollars and cents. It is easy to determine the money saving from the standpoint of compensation paid to nonproductive injured employes and damaged property, but who of us can set a value on a lost life, or a lost limb or eye? Our satisfaction in the knowledge that our efforts have saved a human life is of far greater value than all the dollars and cents saving we can show in operating cost sheets.

Investigation recently completed by the National Bureau of Economic Research of New York shows that on a per capita basis, the people of the Pacific states have a higher average income than those in any other regional group of single states, New York leading, with Pennsylvania second.

Average income of those gainfully employed is highest in South Dakota and New York, a little over $2000. Farmers are well up in the list, as in only one state, Michigan, does the average income of farmers fall below the average of that for all workers.

For the whole country, the total of incomes due to agriculture is about one-sixth of that due to all sources; but for various sections there is wide divergence. The East North Central states are about on the average, and could exist practically as a unit; but the Eastern states derive only one-thirtieth of their income from agriculture and depend on the West North Central states, where one-third the income is from agriculture, for their food.

These facts and much other information which indicates the comparative capacity of states and regions to buy goods and absorb securities are given in the report on "Distribution of Income by States" issued by the Bureau from its headquarters at 474 West 24th St., N. Y. It is part of an investigation on "Income in the United States" which has been going on for two years under direction of Wesley C. Mitchell, Wilfred I. King, Frederick R. Macauley and Oswald W. Knauth, the data being taken from Income Tax Reports, Census Reports, Department of Agriculture Reports, wages data and statements of corporations.

As an indication of the difference between the United States and some European countries, in Constantinople, having a population of 1,200,000, the electric lighting company has an installed capacity of 28,000 kw., put in for service to munitions plants during the war; its maximum demand is now only 9000 kw., and it is seeking to encourage the use of electric current for heating and cooking by making a special rate of 5.75 cents per kw.-hr. for such service.

Oil Power for Water, Ice, and Electric Current

FULL DIESEL ENGINES AS PRIME MOVERS PROVE ECONOMICAL SOURCE OF POWER FOR CENTRAL PLANT IN SMALL TEXAS CITY

TEXAS is oil country. So it is the logical thing that the Alvin Light & Ice Co. should turn to oil for its power. Also heat isn't needed for most of the year; hence oil engines rather than steam would be the natural choice for prime movers. And the performance of the plant has proved that no mistake was made in the selection.

The company furnishes electric current for the city, ice for the local trade, for shipment and for icing cars, and pumps the water supply. And the record for continuous service has been satisfactory, in spite of the fact that during the busy season from May to November there is practically no overload capacity and no spare unit.

In a building 100 by 45 ft. of steel frame construction with brick curtain walls 14 ft. high and a mill type roof is housed the equipment which does the work. As shown in Fig. 1, there are three main units,—two horizontal Diesel engines and a vertical ice machine. The farther engine, 75-hp., is belted to a 50-kw. generator, the nearer one, 100-hp., to the 20-T. compressor; and this engine also has a pulley connected through a clutch which drives another 50-kw. generator. The air compressor for the 100-hp. engine is shown beside it in the nearest foreground, and is driven from an outboard enclosed crank which also drives a two-plunger pump, one plunger to handle lubricating oil from the sump pit to the filter tank on the wall above at the left, the other to transfer fuel oil from the outside reservoir to the supply tank on the floor at the left.

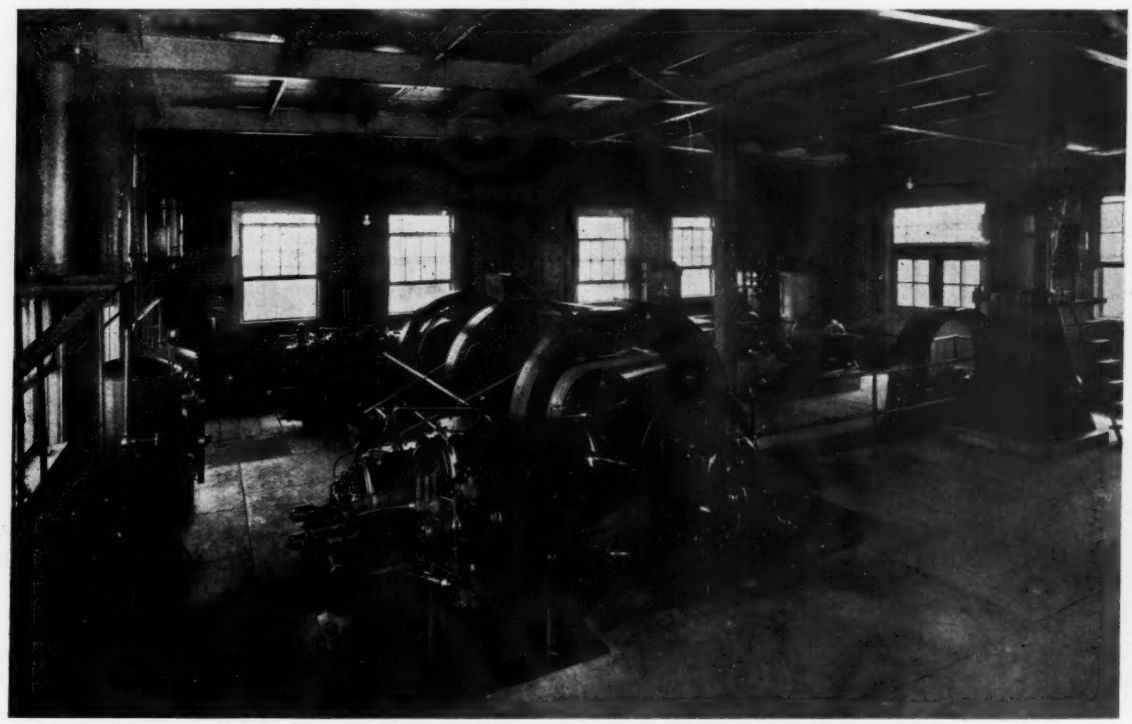


FIG. 1. ENGINE ROOM OF THE DIESEL-DRIVEN PLANT, ALVIN, TEX., LIGHT & ICE CO.

Nearest the crank end of the engine is seen the 8-in. pipe for air intake which leads to the outside of the building. The other 8-in. line below the air compressor is the discharge line connecting to the scavenging air tank below the floor. These two lines connect to the trunk piston in the engine and are controlled by a piston valve in the air compressor which also serves as its crosshead.

Starting air is supplied by a 6-hp. Foos gasoline engine driving a 4.5 by 4.5-in. Curtis single acting vertical air compressor, this unit being located against the wall between the two fuel supply tanks. Each large engine has a starting-air receiver which is filled by this compressor.

Air is used for two special purposes in the plant; to agitate the raw water during freezing and for air lift pumping from the wells to the storage reservoir. For the first, the air is furnished by a 12-stage Sturtevant centrifugal blower, 3600 r.p.m., direct driven by a 7.5-hp. motor, shown in the foreground of Fig. 2. This handles 150 cu. ft. of free air a minute against 3 lb. pressure, taking in the air through the perforated pipe seen at the top on the nearer end, and discharging at the far end through a pipe which leads to the cooler-receiver in the nearest foreground. The air passes through coils in the cooler, which are surrounded by water taken from the fore-cooler of the ice-making system.

For the air lift, the air is supplied by motor-driven reciprocating compressor, seen at the back of Fig. 2 against the wall, with its receiver just to the right.

During the summer, 75,000 gal. of water are pumped a day to the storage reservoir, from which it is forced into the overhead tank, seen on the 100-ft. tower in Fig. 3, by two triplex pumps, gear driven by a 20-hp. motor, located at the base of the tower. The pumps have a capacity of 250 gal. per min. each and the tank has capacity of 50,000 gal.

Air for agitating the water in the ice cans is supplied until it is time to close the core, when the air pipes are withdrawn. The ice tank holds 240 300-lb. cans and freezes 100 cans every 24 hr. or 15 T. of ice. The brine agitator is mounted at one end on a vertical shaft, direct driven by a 5-hp. vertical motor at 900 r.p.m. Ice is stored in a vault 30 by 30 ft. and 7 ft. high, capacity 60 T. in one tier, cooled by a system of direct expansion coils located on the ceiling, and insulated throughout with cork board.

Water for ice making, both for cans and condenser, is pumped from a separate well by a Luitweiler double-acting pump set 60 ft. below ground level and driven by a 7.5-hp. motor. It handles 150 gal. of water a minute. Temperature of the water is so high that the freezing tank temperature cannot be kept below 16 deg. F. which limits the pull of ice to 15 T. a day.

Electric service, light and power, is furnished 24 hr. a day, the heaviest load on the plant being from 6 to 10 p. m., when both engines are loaded to full capacity.

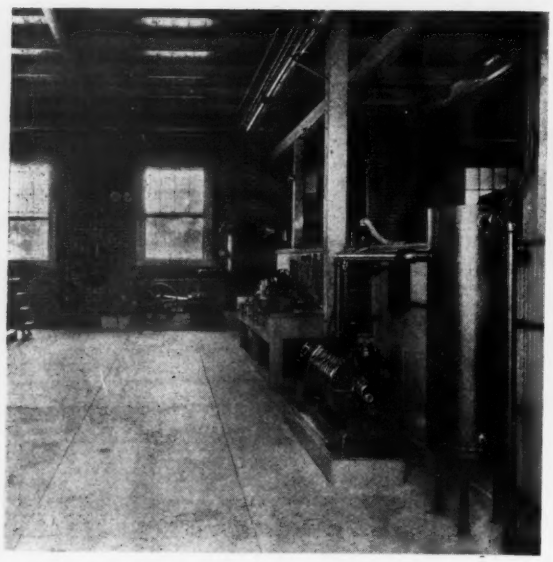


FIG. 2. AIR COMPRESSORS FOR AGITATION OF RAW WATER AND AIR-LIFT PUMPING

The balance of the time the load carried is about 60 per cent of rated power of the engines, but this involves practically continuous service for both engines. The 75-hp. engine was in operation for 6 weeks without shut down, and both engines average to be in service 98 per cent of the time from May 1 to Nov. 1. The engines have been in use 6 and 7 yr., and are giving the best of performance. The load as given is carried on a fuel consumption of 200 gal.,—5 bbl.,—of crude oil a day, Gulf Coast crude being specified because it is least expensive. The price this summer, delivered to the plant has been $1.68 per barrel of 42 gal.

Lubrication for the entire plant requires 5 gal. of oil a day, costing 40 cents a gallon. No record is kept for separate machines.

Fuel oil is stored in an underground concrete tank, shown at the left of Fig. 3, in front of the tower, holding 12,000 gal. It is filled from tank cars by gravity.

The engines are Standard, two-cycle, Diesels made by the Hadfield-Penfield Steel Co., the electrical equipment General Electric, and the ice plant York. Equipment was furnished by the Southern Engine & Pump Co. of Houston, Texas.

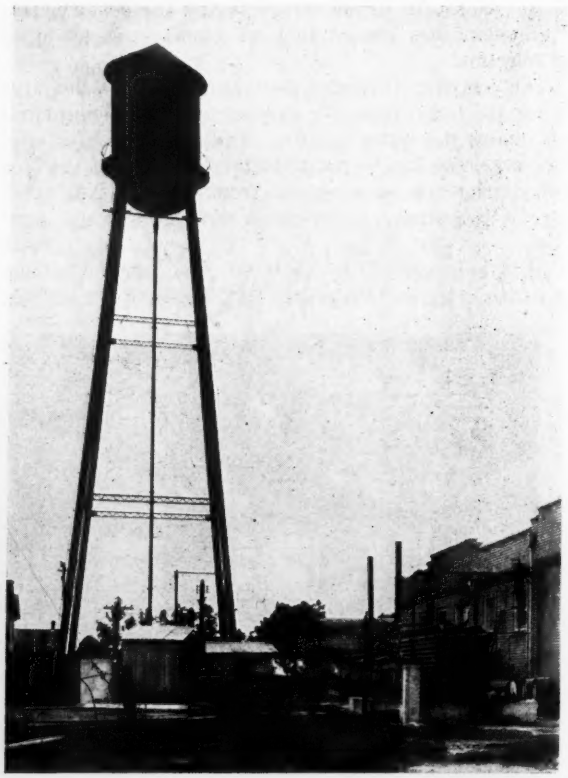


FIG. 3. CONDENSER STANDS, WATER AND FUEL STORAGE

BOMBAY, INDIA, is to utilize the water-power resources of the nearby mountains of the Presidency. The new installation at Nila Mula will be built after bids are let, early in 1923. Contributing to this step are the monsoon floods, needed for irrigation of the mountainous hinterland, the increasing number of mills in the city, proposed electrification of steam trams in town, and projected interurban electric lines.

Next in importance is the Pench River unit, to furnish power to mills and plants for lighting the city of Nagpur, with its population of 101,000. Thirteen other preliminary power surveys totaling an estimated 230,350 kw. have been made at the instigation of the governor of Bombay Presidency.

W. J. DUNKLEY, gas engineer of the Bureau of Mines, has been conducting tests at Ottawa, Ill., of the use of mixtures of Illinois bituminous coal and retort-house coke as water-gas generator fuel in a 6-ft. water gas set operating 10 hr. a day. The work is in co-operation with the American Gas Association.

Oil Engine Hints

Compression of Air; Care of Compressors; Use of Air for Starting. By Bert Bare

COMPRESSORS connected directly to the engine will vary in capacity and working pressures according to the type of engine. The pressure of the starting air need not be as high as the maximum pressure at which the engine works. In the cases where the compression pressure reaches a pressure of 500 lb. per sq. in., the starting pressure need not be more than 350 lb. per sq. in. In the type of engine where there is mechanical injection, that will be the highest pressure at which the compressor will be required to work. In the low compression engines, this pressure need not be over 150 to 200 lb. per sq. in.

Air Compression

WHERE air injection is used, the engine is fitted with compressors to take care of at least a pressure of 1000 lb. per sq. in. This is usually accomplished in three stages. The compressors are of a capacity to take care of the amount of air steadily needed for the injection air and also for an additional amount to replace the air used in starting. When starting up, the compressor should be worked at its maximum capacity. The starting air bottles should be refilled as fast as the compressor can supply the air over and above that required for injection. When the starting air bottle has been replenished, the reserve high-pressure bottle should be filled if that has been pressed into service in starting, and thereafter the compressor will have to supply only the current amount of air for injection. There is a bottle used in connection with the regular injection air which is used as an accumulator and keeps the pressure on the air injection valves steady. The compressor should be regulated when supplying only injection air, so that the amount of air compressed will be just that needed for this purpose.

In some types of compressor design where there are two low compression cylinders, one of them is all that is required for the regular supply of injection air. In other cases, by opening the second stage to the atmosphere on suction and running the first stage idle, the compressor will work as a two-stage compressor and supply enough air for injection.

Where no injection air is used and the supply of starting has been completely restored, the compressor must be fully "cut out." This is done either automatically or the engineer watches the air gage or waits for the relief valve on the tank to blow and tell him that there is enough air on hand. The compressor is "cut out" either by keeping the suction valve open and letting the air flow in and out of the cylinder without compressing, or by closing a valve in the suction line, thus allowing no air to the suction valve at all. The latter method is more frequently used and does not cause the noise that the inrush and discharge of air would make in the other case.

Where the compression does not exceed 350 lb., no particular care of control is needed; but for the high pressure air of 1000 lb. per sq. in., a few points must be carefully taken care of. The clearances must be small and the valves must be looked after to see that they are tight or there will be a marked decrease in the volumetric efficiency. Intercooling must be efficient and the water for this purpose must be of the coolest. The moisture in the atmosphere being incompressible, forms a comparatively large volume when the air is compressed and this water finds its way into the intercoolers and into the storage bottles. The intercoolers are fitted with valves for blowing off this water and the blowing off should be done every half hour.

Water that finds its way over into the storage bottles must likewise be blown off every half hour. For this purpose, a tube is fitted to the bottles and reaches to the lowest point in each bottle so that when the valves are opened, the air forces out the accumulated water and whatever lubricating oil may have found its way over into the bottles. The lubricating oil in this line, as well as the water, is liable to be a real source of danger if not frequently drained as suggested. The high pressure together with the high temperature that compression causes may otherwise cause an explosion of the oil or water, or both.

Compressor Lubrication

TO PREVENT the lubricating oil from getting into the line, it is therefore necessary to prevent as much of the oil from passing the piston as possible. Lubrication of the pistons must be watched so that the amount of oil supplied is a minimum for efficient running. Special care should be taken to see that the wiping arrangement on the piston is in good working order. This wiping arrangement usually takes the form of a thin copper skirt with fingers that press against the sides of the cylinder. On the downward movement of the piston, the fingers scrape off the excess oil and prevent any undue quantity from finding its way past the piston and eventually into the storage bottles.

Air Cooling Coils

COOLING coils of the compressor seldom give trouble but after a term of years it may be that a coil will blow out. The high pressure together with any sharp bends in the pipe or coil will cause wear and weakness. A relief valve of large capacity should be connected so that the water surrounding the coils will have a chance to escape quickly should a pipe burst. A good method is to use a pipe flange to hold a piece of rubber or other suitable material over the water compartment so that if a pipe should give way this gasket will go out and prevent the metal casing from blowing to all parts of the engine room.

Starting on Air

WHEN ready to start the engine, the valve from the starting bottle or tank, must previously have been opened so that there will be available at the engine starting valve the regular supply of air. If only part of the cylinders are fitted with starting valves, the engine must first be turned over to such position that the air supplied to the starting cylinder will be able to take hold when the valve is opened. In installations

where the engine will start up in any position, it sometimes happens that the starting air, having been used, has not pressure enough to turn the engine over. The relief valves to each of the cylinders usually are so connected that all can be opened by the engineer by a single convenient lever. Opening the relief valves for a second and thus relieving the air under pressure in the cylinders under compression, will in most cases be sufficient to let the low pressure of the starting air turn the engine over and start it.

Where air for injection is used, the pressure in that line should be 550 to 600 lb. to start with. It seldom happens, but there is a possibility that the pressure in the line remains up after the previous shut-down so that the engineer thinks that he has opened the injection air bottle valve. In cases where the fuel pump is so connected that the fuel is delivered to the fuel valve, even though that valve is not opening while the starting air is on, the fuel will have no other place to go but back up in the line to the injection bottle. When the engine does not want to start and the pressure in the injection line rises rapidly to 1500 lb. and over, a quick opening of the injection bottle valve will save a blowout somewhere along the line.

High pressure valves at the bottles are usually fitted with lost motion hand wheels so that the valves can be tapped down good and tight. It is better not to be too vigorous in forcing a valve closed, because the valve seat has a very sharp taper and the valve might be driven down too tight. In opening the valve, the reverse tapping must be used to open the valve and a little patience is sometimes needed so that a too forcible blow will not break the valve stem.

It must be remembered that in any article where ailments are discussed, there is a resemblance to a "Home Book on Health." Many people go through life without knowing most of the names even of the diseases that human flesh is heir to.

American Politics Need Industrial Leaders

SPEAKING AT Denver, Dexter N. Kimball, dean of the college of engineering of Cornell University and president of the American Society of Mechanical Engineers, said: "The tendency of the time is for engineers as well as other professional men to interest themselves in municipal, state and national affairs in which they are competent. America needs a new type of industrial leader and if he comes at all he will come from the ranks of the engineer.

"I believe that the first stone was ridiculed and criticized by the cave dwellers; probably because it required two blows with it to finish an adversary; and some years from now when the flying machine from London to New York shall be 10 min. late on a 48-hr. run, people will be found petitioning the international supervisors of flying machines to compel the owners to put on another propeller or another pair of wings and two tails so the service may be prompt; at least I hope they will, for dissatisfaction is the first step in progress. It is difficult to be high minded and hungry at the same time. The farmer is rapidly throwing away his old guesswork processes and soon will emerge a scientific professional worker comparable to the workers in the profession like engineering and medicine, which are lifting themselves from the mire of empiricism and are resting their work on the solid ground of science.

"Efficiency is not the sole criterion by which industrial phenomena are to be finally judged. Whether we will or not, industry is being looked upon more and more as a means of supporting human existence and less as a means of creating individual or co-operative dividends. The most efficient kind of factory for the creating of dividends would be equipped with the highest order of labor-saving machinery and management and operated by slaves. And as we move further and further away from this extreme ideal, so we shall become more and more critical of processes and methods of production. It is going to be a nice problem in social and political organizations to reconcile the many conflicting reactions, and the full import of the movement will be more appreciated as our natural resources become more depleted and the struggle for existence becomes keener."

The Weight of Ice Without Scales

By J. B. Dillon

THE ICEMEN at the refrigerating plant were telling their experience with various housewives bawling them out about short weight. Each man was assertive that he gave full weight. The old engineer, grinning, said, "Boys, there is an easy way to tell the weight of ice without scales. I'll demonstrate it and then you can explain it to the kickers. See this block of ice. Now we will measure it. It is 60 in. long, 30 in. wide and 6 in. thick. We multiply the length, breadth and thickness in inches and that gives us the cubical contents in inches. Now divide that product by 30 and that gives us the weight of the ice in pounds. Let's prove it.

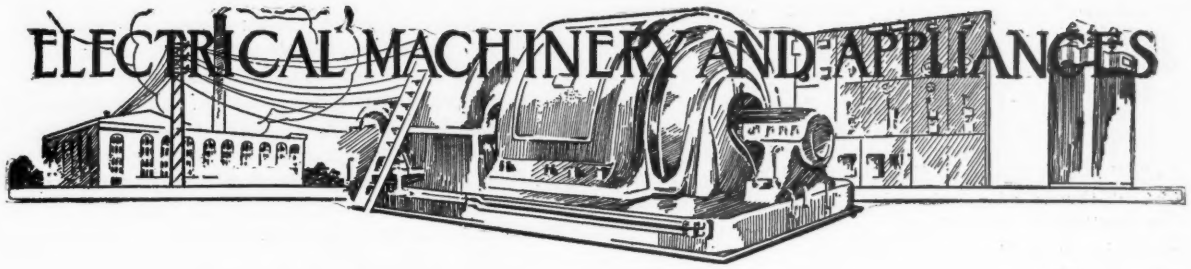
"Sixty times thirty times six equals 10,800 cu. in.; 10,800 divided by 30 equals 360 lb. Now put it on the scales."

The ice was placed on the scale and tipped off at 359.5 lb.

"Well, I'll swear, who'd a' thought it?" was the chorus in unison, as a copy of the formula was made and each prepared to visit the seat of war.

Experiments made by G. W. Vinal and F. W. Altrup of the Bureau of Standards show that at 170 deg. below zero C., both storage and dry cell batteries reverse their voltage.

Watching the storage battery test, it was found that at 80 deg. below the voltage was normal. Between 80 and 100 deg. there was an increment of voltage, although slight. At 100 deg. below the voltage dropped to nothing for a short time and as the cell was further chilled the voltage increased to 10 v., but in an opposite direction, and then it would fluctuate from 10 minus to 10 plus. When the cell was brought back to normal temperature it showed no effects from the "chilly deal" it received and went to work. A dry cell being put through the same treatment reduced its voltage at 115 below zero and at 170 deg. reversed its voltage.



Electric Motor Drive in the Cement Industry

PRACTICAL CONSIDERATIONS IN THE SELECTION, INSTALLATION AND CARE OF ELECTRIC MOTOR EQUIPMENT IN CEMENT MILLS. BY GORDON FOX

THE MANUFACTURE of cement involves mainly crushing and grinding processes. These require a large amount of power, from 15 to 25 kw.-hr. per barrel of cement as a rule. As power cost is a considerable factor in the cost of operations, the items of power generation, distribution and utilization are of interest.

The outstanding characteristics of cement mill machinery may be enumerated as having an important bearing on motor drives. The machinery is bulky, heavy and of a rather rough character. It has high inertia.

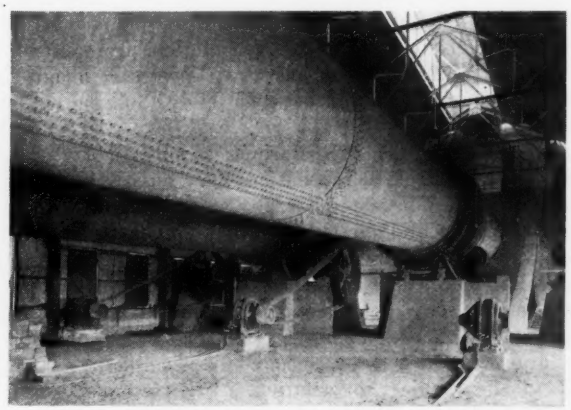


FIG. 1. 75-HP. 440-V. INDUCTION MOTORS DRIVING ROTARY KILNS IN CEMENT MILL. NOTE FINE CEMENT WHICH COVERS EQUIPMENT

It is subject to vibration. The loads in many cases are somewhat fluctuating and overloads and clogging may be experienced. The process is continuous, delays are serious and little opportunity is afforded for maintenance or repair except by enforced shut-down. Most of the machinery operates at constant speed. Exceptionally high starting torques are required by ball mills, tube mills and hammer mills. Motors are subject to a heavy dust laden atmosphere. The class of labor is of a low grade and equipment is subject to more or less abuse.

Direct current motors are used with very good success in a number of mills but alternating current is ordinarily the logical selection. The continuous running, constant speed requirement makes possible the extensive use of the induction motor which is simpler, cheaper and more rugged than the direct current motor. The large volume of power involved will normally be purchased as alternating current. Power may be generated more economically in this form and may be distributed more readily and with a lower investment in copper, due in part to the use of higher voltages.

SELECTION OF FREQUENCY AND VOLTAGE

THE SELECTION of the best frequency is a mooted question. Twenty-five cycles has a number of inherent advantages. Cement mill motors should be low-speed motors. Low-speed, 25-cycle motors are superior

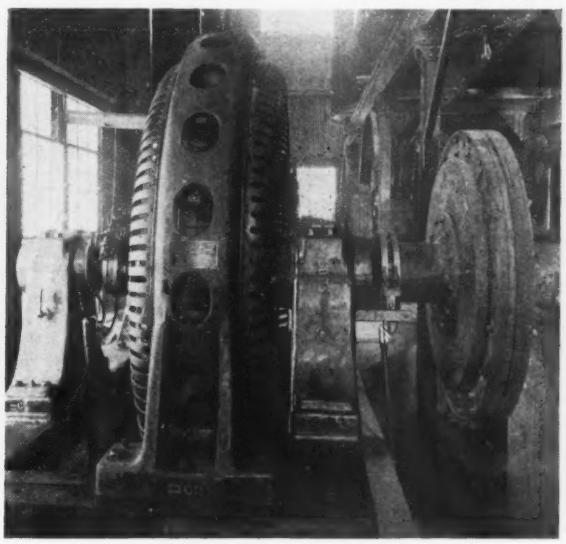


FIG. 2. 500-HP. 3-PHASE SYNCHRONOUS MOTOR DRIVING COMPEB. MILLS, THROUGH A MAGNETIC CLUTCH. COLLECTOR RINGS AT RIGHT DELIVER CURRENT TO MAGNETIC CLUTCH

to equivalent 60-cycle motors in efficiency and power factor. They normally have higher starting torques. They permit wider air gaps without seriously lowering the power factor. Sixty cycles offers advantage in lower cost of generators and transformers. As 60 cycles is the prevailing frequency in this country 60-cycle apparatus is more nearly standard. Public utility power is nearly always at 60 cycles. Even when power is not initially purchased it is highly advantageous that provision be afforded for possible future connection. It is suggested that this be the ruling consideration.

The voltage to be used may depend upon local considerations. In general it may be suggested that power

be generated and distributed at 2300 v. This voltage is sufficiently high to afford economy of copper yet low enough to avoid dust creepage troubles. Some of the larger motors may be wound for this voltage. For the smaller motors and those located in the mills proper the use of 440 v. is common and to be recommended. It is suggested that power be distributed at 2300 v. and transformed at numerous points in a large mill. This practice minimizes copper investment and loss, it assists in maintaining good voltage which is of importance as assuring full torques, and the small transformer banks tend to limit short circuit currents and render safe the use of control equipments of relatively low rupturing capacities.

Although a number of large motors may be installed in a cement mill and high starting torques demanded, the load is quite uniform. Any one motor is a relatively small item. Starts are infrequent and long hours of continuous operation result in a load factor of 65 to 75 per cent, much higher than exists in most industries.

Squirrel Cage vs. the Wound Rotor Motor

There is some controversy as to the relative merits of the squirrel cage and the wound rotor induction motor for cement mill drives. Because of the simplicity and ruggedness of the squirrel cage motor and the absence

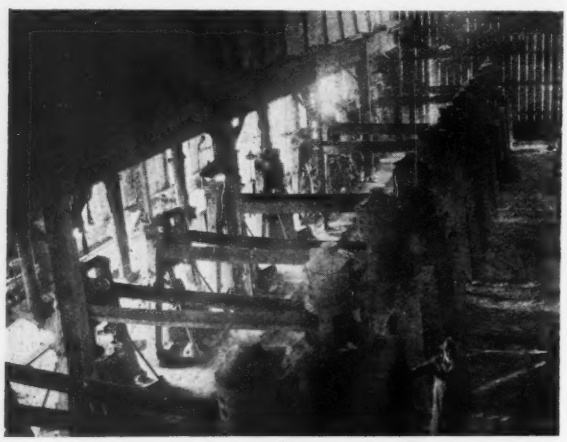


FIG. 3. 12—500-V. INDUCTION MOTORS DRIVING GRIFFEN MILLS IN RAW MATERIAL DEPARTMENT, PEN ALLEN CEMENT CO.

of collectors, the tendency has been to use this type in larger sizes and for heavier duty than in common practice elsewhere. The recently developed indestructible rotor construction of the squirrel cage motor is of particular advantage due to high starting torque and general tendency to abuse. Most cement mill machinery requires a starting torque of at least 125 per cent full load value; some machines require a higher full load torque. In the endeavor to meet these requirements it has been found necessary to develop special design details. In some instances oversize motors have been used or full voltage impressed for starting. The wound rotor motor is better suited in electrical characteristics for this service. It develops higher starting torque and with lower current inrush. Simpler and safer controllers are available for large motors of wound rotor type. The ability to start under worse conditions, as with a machine clogged, gives this motor preference in some cases. The minimizing of line disturbances is occasionally a factor. The wound rotor motor has a higher efficiency than the special, high torque squirrel cage motor. The tendency to larger mills is resulting in increased use of the wound rotor motor. Inasmuch as better starting torques are developed by 25-cycle motors, it follows that the wound rotor type must be more extensively employed on 60-cycle than on 25-cycle systems.

Precautions Against Dust

Because of the heavy dust condition in the cement mill some precautions are advisable. Where feasible, it is well to install motors in separate rooms partitioned off as tightly as possible, driving through openings. It is not necessary totally to enclose motors. Damage by cement dust is principally by abrasion and by stoppage of ventilation. The dust does not affect the insulation directly. Due to the abrasive characteristic it is desirable to provide felt or leather washers and cover gaskets or other approved methods to render the motor bearings as dust-proof as possible. Even with this precaution the bearing oil should be changed and the bearings flushed frequently. The use of split bearings is desirable, particularly on the larger motors, as facilitating renewals which are occasionally necessary. Motors should be mounted off the floor sufficiently to prevent piling up of dust about them. Provision should be made for frequent blowing out of motors, preferably by use of compressed air of moderate pressure, about 30 lb., and with separators or other means to assure that this air is dry.

Because of the high torques demanded and also because of obstructed ventilation, the tendency in cement mill practice is to motor liberally. The disadvantages of low efficiency and power factor and higher investment are offset by lower maintenance charges and also through elimination of delays incident to clogging or stalling, where time may be required to dig out. This condition applies more particularly to crushers. Friction load is a large item with many cement mill machines. As friction load is subject to variation, a little marginal ability is likely to serve to advantage.

Use of Synchronous Motors

Because of the large number of induction motors ordinarily installed and their liberal size and slow speed, the power factor of a cement mill load tends to be rather low. It is usually about 70 to 75 per cent where induction motors exclusively are used. Were it not for the high starting torque demanded, the synchronous motor would be well adapted for driving some of the cement mill machines. Self starting synchronous motors cannot develop sufficient torque for this service, but a number of successful installations have been made on ball mills and tube mills through use of magnetic clutches which permit the motor to start light, the load being applied after the motor has reached synchronous speed. If necessary, it is possible to apply the load gradually by governing the excitation of the clutch. The synchronous motor offers further advantages, other than power factor correction. It develops high pull out torque. It is rugged and has a wide air gap. It is more efficient than the slow-speed induction motor. It seems probable that the synchronous motor will enjoy increas-

ing popularity in this industry. It should be used wherever possible for driving accessory machinery such as air compressors, pumps or fans.

Control Equipment

The control for cement mill motors should be simple. The service is continuous and does not ordinarily involve frequent starts and stops. Maintenance of complex control is difficult and is therefore likely to be mediocre. Manual starters should be used for all but the largest motors. The use of automatic control may be preferable on the larger motors as affording greater protection to the motor and machinery and as being safer for the operator. All control equipment must be tightly enclosed. Automatic control panels should be placed in separate rooms where possible. All starting equipment should be provided with overload relays in two leads of a three phase system. The starting equipment should be liberal or "heavy duty" type and the resistors, where used, should be of the "heavy duty" rating. The use of auto transformer type starters for squirrel cage motors is warranted if a starting voltage of 80 per cent or less is sufficient. If a higher voltage is necessary the motor may as well be thrown directly across the line. Where a number of squirrel cage motors is involved, a separate, reduced voltage starting circuit from taps in the distributing transformers may be used to advantage. This simplifies the control equipment so that some type of double throw switch, usually oil immersed, together with a protective panel, is all that is necessary. The use of indicating ammeters in motor circuits is suggested as showing the condition of the machine or charge and affording an indication of trouble before it develops to serious proportions.

Service and Repair Records for Electric Motors

Describing a System of Records for Keeping Tab on the Condition and Repair of Electric Motors

MANY ELECTRICAL men in charge of maintenance of electric motors are aware of the value of simple printed forms for keeping records of motors in their care. The usefulness of such a record is quickly shown in case of a breakdown. If bearing trouble occurs and a new bearing must be purchased, it is frequently necessary to climb up to the motor with a light, wipe off the name plate and copy data needed for ordering. The markings, if not entirely obliterated, are often in a position making them difficult to read and many errors result. This frequently causes delays in getting a replacement part with a consequent delay in getting the machines into production. With proper records, these difficulties may be entirely avoided and

D. C. MOTOR RECORD Date Installed Shop No.
H. P. Speed Volts
Make Type Frame
Serial No. Specification No.
Open Semi-enclosed Enclosed Shunt Compound Series
Duplicate Motors
Operating Location
BRUSHES No. Width Thickness Length Catalog No.
SHUNT FIELD SERIES FIELD
Weight of wire
Size of wire
No. of turns
BEARINGS Catalog No. Front Back
SHAFT EXTENSION Dia. Length Keyway
PULLEY Dia. Face GEAR Teeth Pitch Face
SLIDE RAILS Yes No
ARMATURE No.
Diagram Lap Wave
No. slots Coils per slot Wires per coil Turns per coil
Size wire Length per coil Total weight
Throw of coils Throw of leads
Catalog No. of coils Coil form No.
COMMUTATOR No. Bars Length Width Length risers
CONTROLLER Make Cat. No.
Reliance Electric & Engineering Co., Cleveland, O.
Form 372

SPARE PART RECORD

Parts Purchased	Date	Qty.	Price	Used Date	Used Motor

REPAIR WORK RECORD

Date	Hours Spent	Parts Repaired	Reason for Repairs

FIG. 1. FRONT AND BACK OF DIRECT CURRENT MOTOR CARD

accurate information may be obtained quickly and easily.

The accompanying illustrations show a simple system of service and repair records for electric motors which were compiled by the Reliance Electric and Engineering Co. of Cleveland, Ohio. These forms will cover the needs of practically all plants, both large and small.

Two forms are shown, one for alternating current motors and the other for direct current machines. For convenience in filing and also to prevent confusion, it is suggested that one form be printed on a different colored stock. The sheets are 5½ by 8½ in. in size and are made for filing in a ring binder. This method is recommended as being most convenient. A binder with flexible cover and one-inch rings can be obtained

File the sheets by horsepower and the cards for each horsepower by shop number.

The report of trouble should give the white lettering on the motor. Assuming that it is a motor marked as above, reference will first be made to the section containing the 5 HP. cards, these will then be followed through to card bearing Shop No. 34, which will show all the information needed at a glance.

If the motor must be replaced, one can readily refer to the duplicate motor cards and decide which one can best be used. If only brushes must be obtained, the record is there.

Under "fields" on the direct current motor card can be shown complete information for rewinding if such work is done in the plant repair shop.

A. C. MOTOR RECORD Date Installed ____ Shop No. ____

H. P. ____ Speed ____ Volts ____ Phase ____ Cycles ____

Make ____ Type ____ Frame ____

Serial No. ____ Specification No. ____ Squirrel Cage / Slip Ring

Duplicate Motors

Driving ____ Location ____

BEARINGS Catalog No. ____ Front ____ Back ____

SHAFT EXTENSION Dia. ____ Length ____ Keyway ____

PULLEY Dia. ____ Face ____ GEAR Teeth ____ Pitch ____ Face ____

SLIDE RAILS Yes / No

STATOR ____ Diagram ____

No. slots ____ Coils per slot ____ Wires per coil ____ Turns per coil ____

Size wire ____ Length per coil ____ Total weight ____

Throw of coils

Catalog No. of coils ____ Coil form No. ____

CONTROL Equipment Make

Type ____ Cat. No. ____

Form 374 Reliance Electric & Engineering Co., Cleveland, O.

SPARE PART RECORD

Parts Purchased	Date	Qty.	Price	Used Date	Used Motor

REPAIR WORK RECORD

Date	Hours Spent	Parts Repaired	Reason for Repairs

FIG. 2. FRONT AND BACK OF RECORD CARD FOR ALTERNATING CURRENT MOTORS

for about $2.50 and will hold about 150 sheets. Index tabs may be made up as desired from special gummed strips designed for the purpose. These can be cut to any suitable length and easily attached to the edge of the cards.

In using these forms, give each motor in the plant a number. Paint this number with the horsepower in large white figures on each motor, thus, 5 HP. No. 34.

From the data on the name plates fill out a card for each motor as fully as possible. The motor manufacturer will gladly supply you with any further information needed for filling out the remaining sections of the form if you wish to keep a more complete record.

If necessary to change pulleys or gears all the needed dimensions will be found under the heading "Shaft Extension" to determine whether extra pulleys and gears on hand will serve the purpose.

Under "Armature" complete data can be given for rewinding either in the plant or at an outside repair shop. Having the size and weight of wire is especially valuable. There is no waiting until armature is torn down to find out what wire is needed. If an outside shop is to do the work you can advise them by phone what wire must be on hand for the job. This will often save many valuable hours.

On the back of the card can be kept a very important

record which will answer such questions as, What are repairs on certain motors costing? Which motor is the cheapest in the long run? Is it worth while paying 10 per cent more for the XYZ make of motor? Is there something wrong with the application of a certain motor? All these can be determined from the record if properly kept.

A record of repair work by hours instead of by cost is recommended due to the varying rates of labor.

By keeping a record of the parts replaced or repaired, weak spots in any particular make of motor will be shown. Noting the reason for repairs will tell whether trouble is due to a fault of the motor or is caused by a misapplication or mechanical troubles outside the motor. Many breakdowns in motors can be eliminated by changes in the machines the motors are driving.

When new motors are purchased, an extra copy of the invoice and a dimension sheet should be obtained from the motor manufacturer and referred to the Electrical Department for the card record. These will give much of the information required. If winding data is wanted it will be necessary to write the manufacturer referring to his order number or motor serial number.

The record of duplicate motors can be kept up-to-date as follows:—After record is in working order and a new motor is added, turn back to sheet for last motor installed of same specifications. Copy duplicate motor numbers on new sheet. The shop number of the new motor should then be added to the sheets of motors of which it is a duplicate.

The value of any system should be determined by the time required to maintain it and the use that can be made of the information recorded.

Keeping up the attached sheets should require a minimum of effort for any record of the kind. The value of the record should be shown frequently in case of trouble. When new equipment is to be purchased the electrician will be prepared to submit recommendations and discuss the merits of the motors under his charge. His recommendations will be considered highly by the Purchasing Department and general manager as his statements can be backed by accurate records.

A Pump Drive Causes Some Agony

AUXILIARY PUMPS OF A COMPRESSOR CHANGED TO MOTOR DRIVE, BUT NOT WITHOUT A LESSON BEING LEARNED. BY ROBERT HAMILTON

WHEN I dropped off the train that morning in a little mining town far up in the Lake Superior country, a cold drizzling rain was falling although it was well along toward the end of June. Possibly the melancholy weather coincided with my feelings, for it was just a bit disheartening to feel that the good old school days were over and that the hard reality of making some kind of showing, or at least a living, had come.

Except for the station agent, the platform was deserted and I was just beginning to feel the same way when a small car appeared on the scene, driven by a black-bearded man attired in the habiliments traditionally associated with the mining country; slouch hat, flannel shirt, high boots and a somewhat dilapidated looking raincoat. As a matter of fact, as I learned later, this is no longer the typical outfit of the mining country, as the white collar, hard hat and other luxuries have taken root and are well supported by the natives.

"Your name is Hamilton?" he asked.

"Yes, that's it," I replied, "and yours is ——?" "Watkins," he smiled in a very friendly way as he held out his hand. "You come along with me and we'll see if we can't find you a bite of breakfast before we start out to look over our layout. It's a good day's work to see just what kind of an outfit you are going to be tied up with and the chief has delegated the job to me, so the sooner we get started the more time we'll have."

After breakfast at Watkins' home, we started out on our tour. The day was a confusion of shaft house, hoisting engine houses, power plants, substations, stamp mills, transmission lines and what not that go with the operation of a big mining property.

After dinner that night when we were just finishing up a couple of good clear Havanas, Watkins suddenly came to life. "By Jove," he exclaimed, "I almost forgot, I figured we would walk down tonight and look over 'D' compressor; that's one of the most interesting machines we've got on the range."

So away we went and the big compressor house soon hove in sight and the steady thump, thump, thump of the discharge into the receiver could be heard.

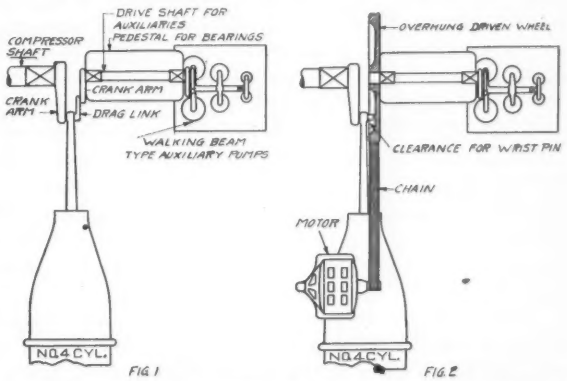


FIG. 1. ORIGINAL METHOD OF DRIVING THE AUXILIARY PUMPS

FIG. 2. AN OVERHUNG DRIVEN WHEEL MADE POSSIBLE BY THE USE OF A CHAIN DRIVE

"This outfit," continued Watkins, as we walked down the hill toward the building, "was installed in 1903 and was originally designed for a 300-lb. boiler pressure, but she is actually operating at 250 lb. The unit is a quadruple expansion, two-stage affair with a very elaborate system of preheating the feed water. There are four feed water heaters in series: No. 1 receives its steam from the exhaust of No. 4 cylinder; No. 2 from the jacket of No. 4 cylinder; No. 3 from the jackets of No. 3 cylinder and No. 3 reheater; No. 4 from the jacket of No. 2 cylinder. As a result, the boiler feed

water leaves No. 4 heater at a temperature of 334 deg. F.

"If you are interested in a test," continued Watkins, "which was run on this machine, I think you will find it outlined in Kent's hand book under performance of a quadruple engine. I believe she showed a steam consumption around 11 lb. per i.hp., which is not so worse."

"Well, here she is," exclaimed Watkins, as we entered the building. "I'll say she's all there," I thumped out involuntarily, for I had never seen more of a maze of flywheels, cylinders, Corliss valves, poppet valves, pipe lines and what not, than there was in the makeup of this machine.

"The total i.hp. developed," explained Watkins, "is about 1575. I have forgotten just what is the diameter of the high-pressure cylinder, but No. 4 is 54 in., which, with a 48-in. stroke, gives quite a volume for steam capacity, I would say."

"Come along with me," beckoned Watkins, "and we will look over the auxiliary pumps. These pumps and the way they are driven are the bane of our existence," Watkins said as we stood looking down into the pit where the auxiliary pumps were located. You see these walking beam pumps cause us a lot of trouble on account of the fact that they are driven by the crank arm for No. 4 cylinder. If the compressor is speeded up to, say, 80 r.p.m., these pumps simply won't stand the gaff, and yet the mining captains are always kicking about not having enough air. We have figured that if we could drive these pumps with a motor and get, say, a speed range from 55 to 65 r.p.m., we could operate the compressor very efficiently and yet speed her up to 85 r.p.m. One trouble, of course, is that any drive that is figured out must allow for the return to the old drive without much delay, for if the electric power went off for a half a day it would be—well, I'm telling you we would hear about it clear from Boston."

"I understand," continued Watkins, that they may push this little job off on you just for a starter. Everybody else has been up to their necks in work, and while the job is a mighty important one, the very fact that it seems to be a tough one has caused it to be left severely alone. I understand that the G. M. is het up over it again, as the compressor was down for 3 hr. the other night on account of trouble with these pumps."

And so as the days went by I found myself camped before a desk in the engineering department, trying to remember just a few of the things which I was supposed to learn in school, and at the same time trying not to show any complete ignorance of the practical game.

"Hamilton, the chief engineer, would like to consult thee." It was the voice of our demon office boy.

Wondering just what I had done to be fired for so soon, I approached the fortress of the chief.

"Watkins tells me that he believes you might like to tackle that pump drive problem over at "D" Compressor," the chief barked at me, as I entered the office.

"Well, Watkins may have had such a hallucination, but I know when I'm well off," I said, being somewhat fresh, which goes along with greenness, "still I don't know but what I might see what I can do."

"All right, get busy," banged the chief. "That's one of the G. M.'s pet schemes, so if you come through maybe you can establish yourself."

I won't tell you how many days I sweat and cussed and figured down in the pump pit at D compressor trying to find some bloomin' way to drive those pumps. Just to give you a rough idea of the layout, Fig. 1 shows the original arrangement.

Baffled at every turn in the pit itself, due to close quarters, the arrangement of the pumps and the fact that a spur or herringbone gear drive was out of the question, I finally decided to see what could be done up at the other end.

As you will note from Fig. 1, the jack shaft driving the auxiliaries was itself driven by means of a drag link tying the crank arm to the extended wristpin of the No. 4 cylinder crank. As you looked at it, there didn't appear to be a chance in the world to put a gear in that space, much less drive it after it was there.

The clearance between the end of the wristpin and the end of the jack shaft bearing was exactly 2½ in., certainly not much allowance to work in a gear. Furthermore, these walking beam pumps were far from a balanced load. Of course when driven off the compressor, this made little difference, but how it would affect a chain drive and a motor was another thing. It would be necessary to have some flywheel action in the driven wheel, otherwise all the shocks would be thrown on the motor and chain.

Some more figuring, and measuring and sweating, but finally I laid out a drive as shown in Fig. 2. The gear was to be overhung on one side so that the wristpin could revolve around inside. This gave a face of 6 in. width, a web thickness of about 2 in. for the driven wheel. The wheel figured out to weigh about 2800 lb., which with a diameter of 6 ft. to give a reduction of 9 to 1, I figured would do the trick.

I might say that according to the test which you will find in your Kent, the i.hp. of the auxiliaries was given as 11. That being the case, I figured that a 20-hp. motor with high starting torque would take care of the load.

The motor which was therefore decided on was 20 hp., 720 r.p.m., 220 v. wound rotor a.c. motor with a continuous duty speed control by means of inserting resistance in the secondary with the usual drum controller.

Sunday is always a bad day around a mine, as there is so much repair work to be done that can't be done at any other time. As a result, a master mechanic is usually about as bad to approach on Friday or Saturday as a man-eating tiger in the wilds of Abyssinia, or wherever it is such pets roam at large.

Nevertheless, it was a job for Saturday night or Sunday, so I approached with the news. The gentlemen in question emitted many varied and entertaining expletives, but finally agreed to see that the job was put in on the following Sunday.

The motor had been set, as you will note from Fig. 2, on the crosshead guide housing of No. 4 cylinder, and all that would be necessary to do would be to disconnect the drag link, pull out the jack shaft and drop the new one, with the gear on one end, in; put on the drive chain and start her up.

In case the electric power should be down and out, due to any unusual situation, the old shaft could easily be put back in with the compressor out of commission for a couple of hours.

Everything went along shipshape, the gear dropped into place and she was all set.

"Start 'er up," called the M. M., and I swung the controller on to the first notch.

Nothing doing.

I swung her over to the second notch, to the third and clear around. Man, if I should never move from here, as a Cornishman would say, she wouldn't budge.

The motor groaned sickly, but that was all.

I never could understand the peculiar endowment of master mechanics; but, man, let me tell you Dr. Jekyll and Mr. Hyde is a mere fairy tale compared to an old line M. M. when something goes wrong that shouldn't. This M. M. whereof I speak changed from just a merely gruff and taciturn individual into a bird so wild that even the Bolsheviks would have called him radical.

Finally with the aid of a crane hooked on the crank-arm we got the outfit started and the ammeter showed a load swinging between 30 and 40 hp. This at least showed that the driven wheel was heavy enough to cut the peaks down in fairly good shape.

Well, they took her down, put the old outfit back and I slunk back to my cell at the boarding house wondering why the college curriculum turned an average man into a nut.

When the G. M. called me to his office the next day, I had already kissed myself goodbye. You know that feeling, some of the boys experienced it over in France; it's a cross between shell shock, cold feet and a devil-may-care attitude. But the G. M. wasn't so bad; in fact, he was quite human.

"I understand," he said, looking at me narrowly, "that your 'D' compressor pump drive didn't pan out quite the way you anticipated?"

"No," I answered, thinking my time had come, "the drive will require a 50-hp. motor instead of the 20-hp. we figured on."

"Hm-m," he scowled ominously, "you figured from the results of that old test, I suppose?"

"Yes, sir," I replied, wondering if I had enough money to get back to Chicago.

Suddenly he smiled rather leniently. "My boy, you have learned one of the lessons we can only get from experience and by having it knocked into us, and that is to make your deductions from your own tests if possible. I am not at all sure of the accuracy of the former tests as far as the auxiliary pumps are concerned. When compared with over 1500 i.hp., the item is rather insignificant at best and at the time we were not interested in that particular detail. In fact, the tests were run so long ago that I have forgotten just how the i.hp. of the pumps was arrived at. The point I am making is that your job should have been to consider the pumps only, rather than to assume that a test run on the entire compressor would give you the data required for your motor drive.

"How does your chain figure," he continued, "will you have an allowance to take care of your increased load with safety?"

"Well, I made a big allowance in the chain for shock and I'm not worried about that part of it," I said with some degree of self-possession. "We will have to put a 50-hp. motor on that outfit, but the drive as laid out will handle it."

"Well, go to it," says the G. M. "Order a 50-hp. motor and see what she'll do," and the G. M. turned to his work with that leave-at-any-time air which executives cultivate assiduously.

But to bring a long story to a close, the 50-hp. motor did the trick and the auxiliary pumps behaved themselves as good pumps should. Old D compressor ran her head off getting up to 85 r.p.m. while the auxiliaries loafed along at 65 r.p.m.

The M. M. and I are on speaking terms again, but I don't know—he's got something on me, and you know what that means.

By the way, my check was 50 bucks a month more after that little incident, but what is more important I have never forgotten the little sermon which the G. M. preached on looking before you leap.

Solutions to Some Belting Problems

SHAFTING ARRANGEMENT AND PULLEY CONDITION PRESENT DIFFICULTIES THAT TAX INGENUITY. BY H. A. JAHNKE

POWER transmission equipment such as pulleys, belting, shafting, bearings, etc., are liable to give considerable trouble at times and frequently it takes some quick thinking and work on the part of the engineer, millwright or whoever is in charge of the power transmission equipment in the plant to keep things moving. These troubles may be due to the fact that some bearing is heating for no apparent reason or a belt may not stay on the pulleys no matter how well the pulleys line up and the shafting is in proper line and level; all these troubles must be overcome quickly so as not to stop production for any length of time in the factory.

Then, again, the management of the plant finds it necessary to add some equipment in the factory to increase production of one thing or another, but in looking over the plant finds that all available space near the line shaft is taken, nor is there floor space enough to place the equipment so it could be driven from the present main or counter shaft, nor is the building in condition to make it possible for installing another line shaft or counter shaft to drive the new equipment without incurring much expense.

It is an easy matter to overcome trouble of this kind where each machine is driven by an individual motor; but where the group drive is in use or all machines are driven from one or two main line shafts which are driven by a motor or engine, the problem is not easy to overcome.

PLACING ANOTHER LINE SHAFT UNDER DIFFICULTIES

SOME TIME ago a case of this kind was encountered where a line shaft was located on each side of the building as shown in Fig. 1, and all available space under and near the two line shafts was taken, making it im-

possible to locate any more equipment so it could receive power from one of the line shafts.

Only one way out of the difficulty presented itself and this was to locate another line shaft in the center of the building as shown in Fig. 1, and drive the new equipment from this; but there was a trolley system of the type shown in Fig. 2, which is made out of channel iron and runs through the entire building in a circle; on to this channel the truck on which the trolley runs is located. This trolley system would not be used after installing the new equipment; but the management did not care to remove the trolley system as it may be used again for some other purpose.

It was finally decided to place the new line shaft above the trolley way. As there were not sufficient posts in the building for placing the shaft hangers and as

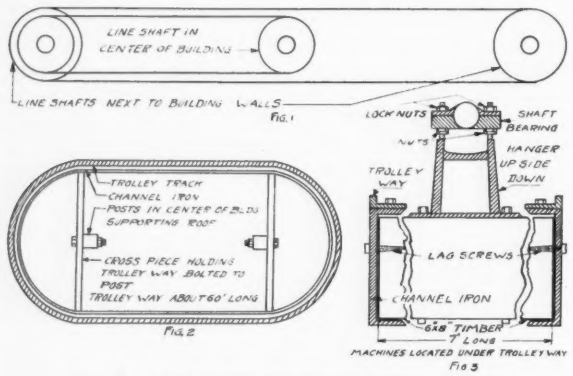


FIG. 1. ARRANGEMENT OF SHAFTING IN SHOP
FIG. 2. PLAN OF TROLLEY WAY
FIG. 3. METHOD OF MOUNTING SHAFT HANGERS

there was no way of placing more posts on account of the trolley runway, the shaft hanger supports were arranged as shown in Fig. 3, by placing 6 by 8-in. timber between the two channels of the trolley runway. These timbers had a tight fit, so they had to be driven in place with a heavy hammer, then ½-in. holes were drilled into the channels and ½-in. lag screws 6 in. long were placed through the channels into the timbers as shown. The timbers were placed 8 ft. apart along the trolley way.

In order to have as long a distance as was possible between the line shaft and shaft on apparatus to be located under the trolley way, also to clear the belt driving the new line shaft from the main line so it would not strike the trolley way, shaft hangers of the type shown in Fig. 3 were used and placed upside down. These hangers were bolted to the timbers with machine bolts.

At first I was afraid that there would be some shaking of the trolley way, perhaps causing hot bearings, but there is no sign of this.

Large Idler Pulley Did the Trick

An 8-in. rubber belt driving a secondary line shaft from the main line shaft was replaced by an 8-in. double leather belt. The new belt was placed at night after closing down time and made endless. The next morning after a few hours' run, the belt had stretched so much that it would not pull the load, and I was afraid of burning the belt if I ran it in this condition much longer.

If the belt had been jointed with some belt lacing, it would have been an easy matter to get out of the difficulty by shutting down the plant for a short time to shorten the belt; but as the belt was endless, it would take from 3 to 4 hr. to do the work, taking into consideration that the joint must be taken apart first, then remade, and the time for the glue to dry before the belt clamps could be removed. Of course I could have gotten out of the difficulty quickly by cutting the belt, then shortening it and jointing it together again with lacing, having it made endless again when there was more time; but this the management would not allow.

The distance between the driving and driven shaft on which the belt was located was quite long and there was a stationary idler pulley located under the belt about midway as shown in Fig. 4. This idler pulley was not there to prevent the belt from slipping but to guide it over some obstacle that was in the way of its travel, whenever it got a little loose.

It was decided to replace the small idler pulley with a larger pulley. This would take the slack out of the belt, and prevent the slipping.

The pulley on the idler and the one I intended to replace it with, which was taken from stock, were of the wood split type.

After I had the larger pulley all ready to be placed on the idler shaft I shut the plant down long enough to remove the small pulley and place the larger one which took only a short time when the plant was in operation again. This took the slack out of the belt so it pulled the load without slipping until there was more time to shorten the belt, when I replaced the small idler pulley again.

Crowning Two Wood Pulleys

In another instance, I installed a line shaft which was driven from the main shaft. After all was ready

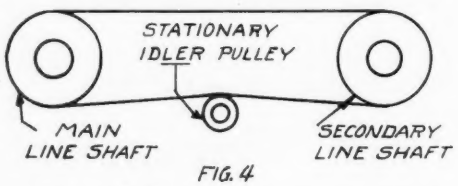


FIG. 4

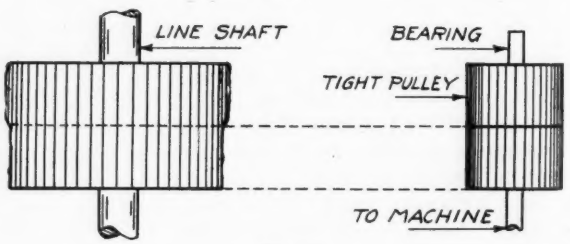


FIG. 5

FIG. 4. LOCATION OF STATIONARY PULLEY REPLACED BY ONE OF LARGER DIAMETER TO TAKE UP SLACK
FIG. 5. ROUGH PULLEY FACE CAUSED SHIFTING OF BELT

to run, I found that the belt was bound to run to one side of the pulley. I was sure that both pulleys were lined up and the shafts were in line and level, but I found that both pulleys had straight faces, instead of being crowned as I had thought they were. The shaft had to run in a short time, and as no wood lathe was

available a wood rasp was used to form a crown. I had the belt removed and the pulley that was on the secondary shaft placed on the main line shaft; then turning the engine over at a lower speed than it usually runs, I put two men to work on both pulleys with a wood rasp and had a crown on them in a short time, finishing the job with sandpaper so as to have a smooth surface on the pulleys. The pulley was placed on the secondary shaft again, belt put on and after starting up the belt run in the center of both pulleys without further trouble.

Both pulleys in question were of the wood split type, 18 in. diameter and 10 in. face.

Unevenness of Pulley Surface Causes Trouble

In still another instance where a machine was driven directly from the line shaft by a 3-in. double leather shifted belt, this belt would not stay on the loose pulley when shifted there, but would crawl onto the tight pulley. The arrangement of the drive is shown in Fig. 5.

There was danger of the belt crawling over on the tight pulley and starting the machine unexpectedly, thereby injuring some employe.

In looking for the trouble, I found that all was in line and level, but that the whole trouble was caused by unevenness of the surface of the split wood pulley on the line shaft driving the machine. The unevenness of the pulley surface is shown at A (which is exaggerated to make the matter more plain). This unevenness of the pulley's surface, such as the high and low points, would cause the belt to crawl onto the tight pulley, as after the pulley surface was trued up again by a wood turning concern, there was no further trouble.

The unevenness of the pulley surface was caused by much belt slipping.

Distinctive European Power Plant Equipment

Continuous Water Purifier; Use of Corrugated Piping; Steam Accumulator; Boiler Tube Cleaner. By J. H. Blakey

THE GAILLET water purifier consists of four parts: the distributing tank, the automatic reagent saturator, the chemical reaction chamber and the clarifier. The action of the apparatus is as follows: The water to be purified arrives at the valve A (Fig. 1) through which it flows into the tank C, being shut off by the action of the float B when it has reached the proper level. When the water supply is irregular, it is led into the tank by a pipe at D connected by a flexible tube E to a partitioned float F which when immersed acts as a siphon, feeding the cocks G and H. The cock G directs a previously determined amount of water into the saturator K, the function of which is the continuous preparation of lime water, which is an essential reagent in the economical treatment of most natural waters. The remainder of the water passes through H and reaches the reaction chamber L, in which the sediment settles. The orifice N enables the saturated lime water in K to join the main stream at N.

Thus it is a mixture of the original water and the reagent which flows to the bottom of the reaction chamber and into the clarifier, rising through the pyramidal surfaces P and finally through the metallic filter Q, passing out clarified and purified at R. The evacuation of the sediment is effected by means of the valves W. When there is occasion to employ some other reagent, such as soda, it is dissolved in the tank S, from which it flows, by means of a constant level regulator T and a measuring cock V, into the mixture of untreated and lime water.

To prevent the derangement of the apparatus, there is a siphon float DEF which, when running normal, is immersed, and which as soon as the discharge from the feed water pipe is less than that from the cocks G and H, rises above the level of the water and suspends the flow until the normal level is re-established. By this means, the discharges of water and of the reagent continue absolutely proportional, whatever the volume of water coming into the purifier.

Another float controls the articulated pipe V which distributes the soda and assures a discharge of the reagent proportional to the supply of feed water. To make the apparatus automatic, there is placed in the clarifier a float X the stem of which is surmounted by a fork Y, in which the rod of the valve A rests. Thus the flow and stoppage of the water at R automatically controls the action of the valve A.

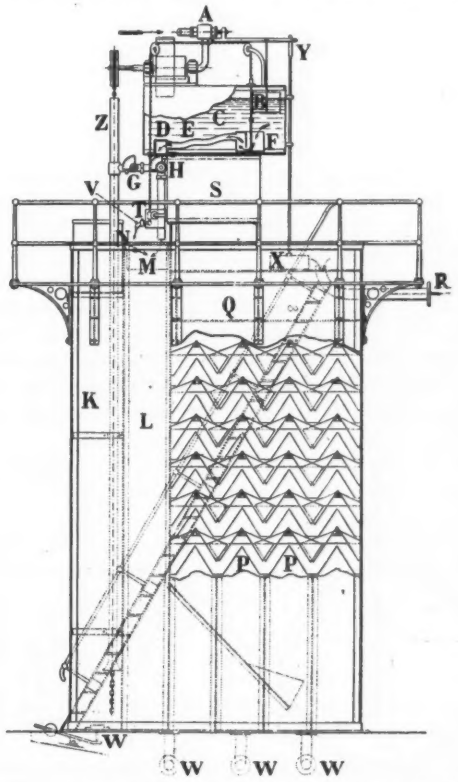


FIG. 1. SECTIONAL VIEW OF GAILLET WATER PURIFIER

Corrugated Tubes for High Pressure Steam

In the Genie Civil for August 5, M. Joessel discusses the use of corrugated pipes for high pressure

installations. In France this form of pipe is manufactured by the Compagnie des Forges d'Audincourt (Doubs), and the writer describes the methods used, in which great care is taken to maintain a uniform thickness of the tube wall. This is a great advantage when

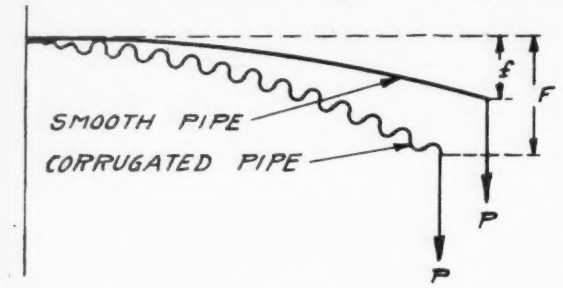


FIG. 2

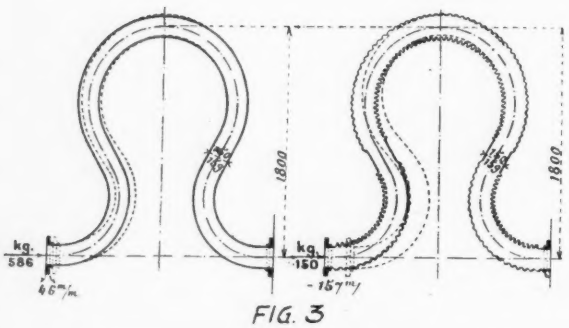


FIG. 3

FIG. 2. DIFFERENCE OF DEFLECTION OF A SMOOTH AND CORRUGATED PIPE

FIG. 3. COMPARATIVE DEFORMATION OF EXPANSION LOOPS MADE FROM SMOOTH AND CORRUGATED PIPE

this form of pipe is used for expansion loops, as any bending of a smooth pipe necessarily creates tension and compression stresses in the outer and inner surface of the bend. The claims made for these tubes are as follows: a high elasticity in the longitudinal direction, a greater resistance to pressure, internal or external, on account of the even thickness of the wall, greater ease of curvature into any form, and their high value as shock absorbers as compared with smooth pipe. Used without covering, they of course radiate more heat because of the greater amount of surface exposed; but with a covering it is claimed they retain heat better than the smooth pipe because of the enclosed air space between corrugations. They have one disadvantage, however: used in high pressure steam installations they cause a fall of pressure which may amount to double that with smooth pipes, varying, of course, according to conditions.

The use of corrugated pipe is indicated in all installations where great differences of temperature occur, and also where the piping is subjected to shocks, as in a locomotive, on shipboard, or with steam hammers. They have proved their value in various kinds of boilers, both fire tube and water tube, as it has been found that there is less danger of leakage at the tube plate, due to unequal contraction and expansion, than when smooth tubes are used.

The writer gives a formula which shows that the total variation in the length, in millimeters, of a straight corrugated pipe must be less than one-sixth of the number of corrugations in that length; from this he deduces the rule that with pipes of ordinary size, using saturated steam, one length of corrugated pipe will compensate the expansion of two lengths of smooth pipe; with superheated steam it is necessary to use twice as many lengths of corrugated pipe as of smooth pipe.

Figure 2 shows the difference of deflection of a smooth and corrugated pipe under the same load P; it is found that F is equal to about 12f. This property is of obvious value in the formation of an expansion loop, as shown in Fig. 3.

This form of pipe has also been used with very satisfactory results in compressed air installations for coal mines.

The Ruths' Steam Accumulator

A description of this accumulator appeared in Power Plant Engineering for March 1, 1922.

In Zeitschrift des Vereines deutscher Ingenieure for May 27, June 3 and 17, M. Ruths gives an extensive study of his apparatus, which in addition to the drawings already given contains one in fuller detail, which is shown in Fig. 4. The steam pipe *C* brings steam from the boilers, one branch entering the steam dome and the other arching over this to enter the accumulator. This latter discharges into a long horizontal tube *u*, just below the water level. On the lower side of this are

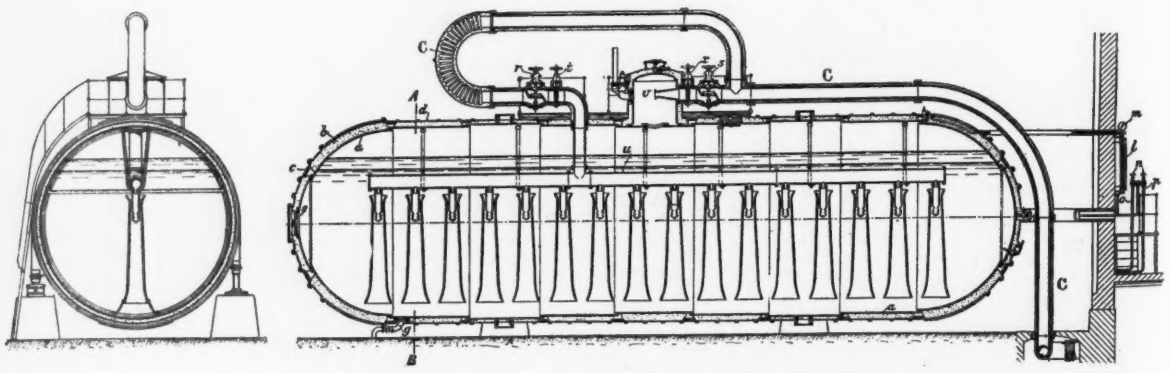


FIG. 4. SECTIONAL VIEW OF RUTHS' STEAM ACCUMULATOR

vertical nozzles opening into diffusers which extend almost to the bottom of the accumulator. It will be seen that by closing valves x and s, and opening r and t, the steam from the boilers passes into the accumulator. On the other hand, at times of heavy load valves r and t are closed and x and s opened, so that steam returns to the boilers or to the auxiliary engines which require it. The inner shell a is of sufficient strength to withstand the pressure for which the accumulator is designed, but the purpose of the outer shell d is simply to protect the heat insulator b. At one end is a manhole at e, and at the other are tubes o and p for adding water, a water level l and a pressure gage m.

The "Paradox" Boiler Tube Cleaner

This boiler tube cleaner was invented in Italy, where it is in universal use for both marine and stationary boilers; it is also being used to a great extent

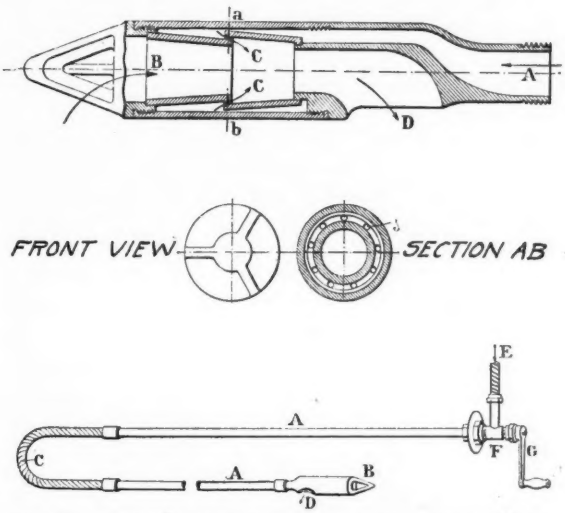


FIG. 5. SECTIONS AND ASSEMBLED VIEWS OF PARADOX BOILER TUBE CLEANER

in France. The principle on which it works is similar to that of the Giffard injector; it sucks the hot gases from the combustion chamber, and drives them, in combination with a jet of steam, violently against the parts to be cleaned. The apparatus is shown in Fig. 5. The jet of steam is sent into the head by the orifice A and passes with great violence through the openings CC, which are holes of 1/10 in. diameter. This draws the combustion gases from the firebox through the open head B. The intimate mixture of steam and gas, at a temperature of about 1000 deg. C. forms a current coming out at D with considerable speed and at an angle of about 45 deg., driving the soot into the combustion chamber. In the assembled view E, of about ⅝ in. diameter, is the steam connection with the boiler, A is a hollow rod of suitable size, and C is a flexible tube reinforced with steel. The handle G enables the operator to turn the head into any required position.

In discussing the prospects of finding a remedy for the steady dissipation of iron in the form of rust, it was estimated by Sir Robert Hadfield that the annual dissipation of iron amounts to 29,000,000 tons. This is not far removed from one-quarter of the world's normal output.

Keeping Boiler Tubes Clean

By R. L. Mossman

THE following tests made by the writer on a 500-hp. water-tube boiler show the importance of blowing the tubes daily.

This boiler was equipped with soot blowers of a well known make.

The steam flow meter, steam temperatures from the super-heater, and watt-hour meter readings were taken every hour.

In test No. 1, the tubes were blown 24 hr. previous to starting the test, and were not blown for the following 24 hr.; this allowed a 24-hr. deposit of soot on the tubes when the test was started.

In test No. 2 the tubes were blown when the test was started and once during the test.

Test No. 1

Duration	24 hr., 7 a.m. to 7 a.m.
Coal used	24,900 lb.
Average boiler horsepower	280
Per cent of boiler rating	56
Average boiler pressure	170 lb. gage
Average superheat of steam	100 deg. F.
Average temperature of feed water	190 deg. F.
Pounds of coal per boiler horsepower	3.7
Pounds of coal per kilowatt-hours	5.23
Total kilowatt output	4758
Boiler efficiency	67 per cent

Test No. 2

Duration	24 hr., 7 a.m. to 7 a.m.
Coal used	23,800 lb.
Average boiler horsepower	275
Per cent of boiler rating	55
Average boiler pressure	170 lb. gage
Average superheat of steam	110 deg. F.
Average temperature of feed water	193 deg. F.
Pounds of coal per boiler horsepower	3.6
Pounds of coal per kilowatt-hour	5.12
Total kilowatt output	4646
Boiler efficiency	69 per cent

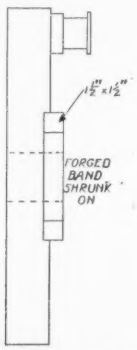
The result of these tests shows a reduction of about 2 per cent in coal per kilowatt-hour, a reduction of about 3 per cent in pounds of coal per boiler horsepower and an increase in the superheat of the steam of about 10 deg. F. It was noted that the instant that the tubes were blown, the superheat increased from 25 to 30 deg. During test No. 2, the temperature of the flue gas was 50 deg. less than in test No. 1.

As will be seen by these tests, the small amount of soot that would accumulate on the tube in 48 hr. decreased the boiler efficiency about 2 per cent, this being based on 13,500 B.t.u. per lb. of coal.

It is estimated that in the state of Sao Paulo, Brazil, there is available 2,800,000 hp. of hydraulic power, of which less than one-tenth is now developed. The two largest plants in operation are one of 32,000 hp. on the River Tiete and one of 50,000 hp. on the Sorocaba River, both of which transmit to the city of Sao Paulo at 88,000 volts. Over 50 hydroelectric plants in the state supply current to 236 cities and towns, the total power developed being 122,000 hp.

Water Softener Performance; Crank Disk Repair

NOT LONG ago we had occasion to suspect that there was oil in a couple of our boilers and on examination found small deposits in boilers No. 9 and 12. We immediately came to the conclusion that our feed water heater, which is of the horizontal type with an oil separator at one end, was at fault. Accordingly after the heater had been allowed to cool down, my chief engineer and I crawled inside to make an inspection. We found the baffle plate hanging down, due to the fact that the bolts at the far end had been broken off. This condition we remedied, of course, and at the same time



COLLAR SHRUNK ON CRANK DISK HUB

cleaned out the heater. This was the first time this unit had been opened up for three months and at that we were only able to find about a pail full of scale on the bottom. In this connection I might say also that we have not turbined a single tube in our boilers for four years and we have no trouble with scale whatsoever. This, I think, speaks fairly well for our water softening apparatus which is a cold process lime and soda system.

When a crankpin disk cracks, it usually means a long shutdown until a new one can be placed. This delay is of course costly and it is therefore well to know how to make a quick repair in such an event.

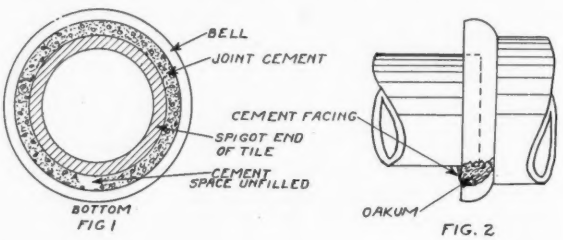
Last March one of our generator engines cracked a crankpin disk at the hub, immediately adjacent to the shaft. We decided to put a collar over the hub to hold the disk intact. Accordingly we rigged up a tool to recess a channel in the disk. The inside diameter of this channel was the same as the outside diameter of the hub—15½ in. The outside was 18½ in., giving a channel 1½ in. wide. The depth of the channel from the face of the hub was also 1½ in. In this channel we fitted a 1½ by 1½ by 15½ inside diameter by 18½ outside diameter forged steel collar. When this collar was shrunk into place, it made a disk almost as good as new. The part has been giving service ever since at the rate of 24 hr. a day. We started this job one morning at 9:00 o'clock and had the band in the next afternoon at 3:00.

F. C. BERTHOLD.

Filling Sewer Tile Joints

ENGINEERS operating in mills and factories are usually mixed up in many things not coming strictly under the head of power plant operation. One of the jobs we have had much trouble with getting properly done is sewer laying.

Sanitary sewers laid through clay ground with plenty of fall, with uncemented or poorly made joints will be fairly satisfactory, provided there are no trees in the vicinity; if there are, the roots will penetrate the sewer at the joints, forming a mat that completely plugs the passage. We have had sewer men argue that tree roots would find their way into a sewer with properly cemented joints; this is not the case.



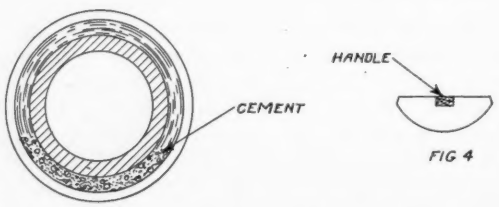


FIG. 1. DEFECTIVE SEWER TILE JOINT

FIG. 2. JOINT FILLED WITH OAKUM AND FACED WITH CEMENT

FIG. 3. METHOD OF INSURING BOTTOM SIDE OF MALE END OF TILE BEING PROPERLY BEDDED IN CEMENT

FIG. 4. SCRAPER FOR REMOVING ANY CEMENT THAT ACCUMULATES INSIDE THE PIPE WHEN MAKING JOINTS

Figure 1 shows a defect that will usually exist in five out of six joints where the workman tries to fill the joint by pressing the cement in place with his fingers after the tile is in position. I have made workmen tear out considerable quantities of small tile when I found they were making the joints in this manner and found

practically every joint defective as shown. This trouble is easily avoided by placing sufficient cement in the bottom part of the bell, slipping the spigot end of the tile in place and pressing it into the cement, then the rest of the space can be filled with the assurance that a good joint has been made.

Figure 2 shows how a number of joints were made that would have caused serious difficulty if the trouble had not been discovered before filling in. In this case, the tile carried brine from a hardening operation to a cistern, whence it was pumped through cooling coils and back to the hardening room. As illustrated, the bell space is filled with oakum and faced with cement, making a fine appearing job, but utterly worthless. Fortunately we became suspicious and discovered the trick in time. It was probably due to ignorance; at that, the contractor makes his living laying house sewers for plumbing firms.

Workmen who are careless or ignorant will feed cement into a joint as long as they can make it go, with the result that the tile is plugged at that joint if they are not compelled to swab it out. I have had this happen even with a conscientious inspector trying to get the job done right. A segment of board about as shown in the sketch is very good for raking out any cement that finds its way inside. It is quite a trick to cut a hole in a vitrified tile or cut it in two, but it can be done if due care is used. The tile should, if not in place in the ground, be bedded in a pile of loose dirt or ashes. For cutting a hole, we usually use a sharp-pointed punch and keep going around the outline of the piece to be removed until the sharp point of the punch goes through, then break through around the piece and the piece drops out. To cut one in two, use the same method only a sharp chisel may be substituted for the punch.

J. O. Benefiel.

Remedies for Heating System Troubles

Now that the heating season is almost with us, and preparations are being made by eliminating the troubles and noises experienced the year before, the various articles that have recently appeared in Power Plant Engineering should be referred to for suggestions.

In an article by H. A. Jahnke, on page 666 of the July 1 issue, some practical features were described and illustrations were given to show the manner in which a number of difficulties were overcome. For these purposes air vents and thermostatic traps were used, with apparent satisfaction and improvement in circulation. It follows logically, that there was also a saving in coal. The main features were the elimination of noises and the removal of water from steam lines or appliances.

Typical sketches from the illustrations originally presented are shown in Figs. 1 and 2. While these show the principles employed, they really are not the best ways of installing the appliances, if the utmost in results be desired. In Figs. 3 and 4 are shown methods of connecting the valves which are considered not only proper, but fully effective.

When an air vent is connected through a side outlet, or at the end, the tendency is to make it inoperative due to the slugs of water traveling in that direction, or that may be entrained in the steam flowing through the line. Locating the air vent on top of the main or one of its fittings, does away with this possible trouble, and places the air vent more nearly in line to perform its functions of air elimination. A quick vent rather than a radiator air valve should be employed.

So far as the thermostatic trap is concerned, a size smaller than ¾ in. should not be used for drip purposes. Water of condensation has the same temperature as the steam and, therefore, to make absolutely certain that water will not accumulate in the steam main or heating riser, it becomes necessary to provide a condensing or cooling leg between the drip point and the trap. This leg should not be of less than ¾ in. pipe, in a horizontal plane, and 4 ft. or more in length.

Observation of these small details will give more certain and even better results than testified to by several

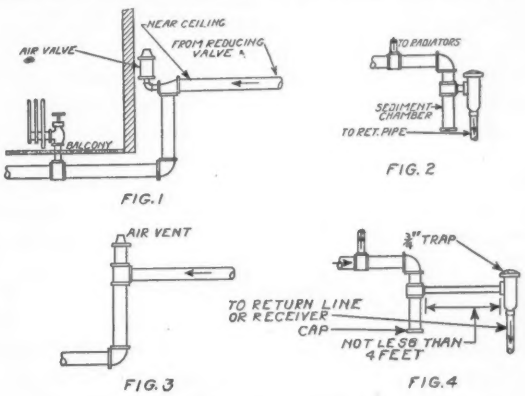


FIG. 1. IMPROPER LOCATION OF AIR VALVE
FIG. 2. THERMOSTATIC TRAP TOO CLOSE TO LINE
FIG. 3. PROPER LOCATION OF AIR VENT
FIG. 4. PROPER METHOD OF CONNECTING THERMOSTATIC DRIP TRAP

engineers who have contributed to these columns on this most important subject of heating.

M. William Ehrlich.

Packing Piston Rods

When valve or other rods become worn, often due to neglect in removing hardened packing from the box, leaks develop at the glands. The gland nuts are tightened, perhaps several times a day, in an attempt to keep the joint steam tight; this compresses the packing to such an extent that the wear upon the rod might be nearly as great as that caused by the old packing.

Of course the only permanent remedy is to have the rod repaired or replaced with a new one. There are ways to lessen the trouble without going to this expense. One of these ways is to pack shredded lead or thin soft tea lead into the box for about a quarter of its depth, a ring of the regular packing on top of this, then more lead and continue this process until the box is filled. Experiment has shown that this simple scheme will often keep a joint tight for several weeks that would not remain tight for as many days when packed in the regular way.

Sometimes the holes in the gland and the box are enlarged by wear and the rod badly scored, the latter probably caused by hard tight packing and defective lubrication. When this condition exists, the rod will shred or tear the packing and draw it into the cylinder

or force it through the gland in a powdered form; this will in a short time reduce the quantity of the packing in the box to such an extent that even tightening the gland nuts will not make a steam tight joint unless more packing is added.

To help reduce this trouble, have two metal rings made with the hole a tight fit for the rod, the outside diameter of the ring being the same as the inside diameter of the box. Cut the rings exactly in half and place the two halves of one in the box with the combination packing on top of it and the other ring on top of the packing when the box is fitted. If the box it deep it will help further to use a third cut ring about halfway in the box. The rings can be made from a good hard babbit metal, although brass is better. After the rings are cast, cut, and fitted, drill holes for dowel pins in the faces of each cut and use tight pins in the holes when placing them upon the rod.

When this simple repair is made carefully, it will greatly reduce the trouble and incidentally reduce the packing cost. I know of one case where the piston rod of a high-speed engine persisted in heating after a dozen different remedies had been tried. Using the combination packing and babbit rings as described, proved a permanent cure. JAMES E. NOBLE.

Daily Report Blanks

I HAVE NOTICED in several recent issues of Power Plant Engineering log sheets, reports, etc., have been published that are being used by different plants over the country, but I haven't seen one yet that is like one that we use, so I am sending copies of our Engineers' and Firemen's Daily Shift Reports. These are not the only log sheets that we use, but they are used in connection with our condenser, ice plant, generator and boiler room logs, which are much like some that you have printed. Our plant is, as may be seen from the reports, a combined ice and power plant, and we use natural gas and oil for fuel. W. M. MILTON.

Suggestions Lead to Economy

IN AN hydroelectric power house in northern California were installed two 5000-kv.a. generators each driven by two overhung Pelton water wheels and operating under a head of almost 700 ft. Neither one of these machines could be loaded up to more than 4000 kv.a., due to the fact that they would heat up excessively.

In accordance with a suggestion made by one of the operators, the vent holes in the frame of the generators were blocked up with the exception of the top two holes. A sheet iron pipe was run from these holes down to the space box around the double nozzles of the water wheels where there existed a high suction due to the injector action of the water. This suction then acted to draw ventilating air into the generator around the shaft—the air passing out through the windings and out the sheet iron tube to the space box around the double nozzle. The action of this arrangement was entirely automatic inasmuch as the greater the load on the generator the more water ran through the nozzles and the greater the suction. The result of the arrangement was that the machines thereafter carried 6000 kv.a. with greater ease than they had before carried 4000.

The man who made that suggestion was so encouraged by its successful adoption that he was continually on the lookout for improvements and succeeded in having several other excellent ideas adopted. The result

ENGINEER'S DAILY SHIFT REPORT

DATE _____ 192__

	Gen. 1	Gen. 2	Aux. Power	Ice Power	Elec. Light	Ice Light	Ice Steam	
Present								
Previous								
Difference								
Constant	1000	100	100	10			3110	
Total								

OIL USED		FUEL USED			
Eng. Oil	pts.	Total Gas	cu. ft.	Total Oil	Gals
Cyl. Oil	pts.	Ice Gas	cu. ft.	Ice Oil	Gals.
Amm. Oil	pts.	Elec. Gas	cu. ft.	Elec. Oil	Gals.
Turb. Oil	Gals.	Gas per K. W. H.	cu. ft.	Oil per K. W. H.	Gals.

ICE PLANT

Tons Ice Effect Vaults	Ice Pullers by Name	Brought forward	blocks
Tons Ice Manufactured		Ice pulled	blocks
Total Tons Ice Equivalent		Monthly total	blocks
K. W. H. per ton Ice Equivalent	Gas per ton Ice equiv.	Oil Per Ton Ice Equiv	

Remarks, Suggestions, etc.

FROM _____ M. TO _____ M. SIGNED _____

FIREMEN'S DAILY SHIFT REPORT

DATE _____ 192__

	G. Meter 1	G. Meter 2	Oil Meter	V. Meter	W. Meter	F. Meter 1	F. Meter 2	F. Meter 3
PRES.								
PREV.								
DIFFERENCE								
CONSTANT	100	100	10	100		17740	17740	17740
TOTAL								

WIME	Gas	Oil	Stack Draft	Gas. Pres. On Burner	Open On Burner	Evap. per Cuft. Gas	Water Used	Stack Temp.

Remarks, Suggestions, etc.

FROM _____ M. TO _____ M. SIGNED _____

BLANKS USED BY ENGINEERS AND FIREMEN IN A COMBINED ICE AND POWER PLANT

of fostering and encouraging constructive thought on the part of employes invariably results in better work and more careful and painstaking operation.

Another instance where the suggestion of an employe was adopted to good advantage was in a large steam operated standby power plant in a Western power corporation. At this station were installed some 30 B. & W. and Stirling boilers in the boiler house. In the turbine room, on the other side of the brick wall, were installed 3 vertical G. E. Curtis type 18,500-kv.a. turbines and one 20,000-kv.a. horizontal unit. On this side were also installed two 5000-kv.a. engine driven generators, and all the switching and control apparatus. There seemed to be little or no co-operation between the turbine room and the boiler room forces. When the load dispatcher ordered the chief operator to pick up another 15,000 kw., the latter would notify the engineer on watch. The engineer in turn was supposed to go out into the boiler house and notify the fireman of the increase in load.

Many times the transferring of this information from man to man verbally, is delayed or not delivered until it arrives too late to be of value, and the dropping of the steam pressure was the first intimation received by the boiler room of an increase in load.

In order to remedy these conditions, one of the employes suggested that there be installed a pair of numbered dials provided with pointers and connected by rods and mitre gears so that when the dial on the switchboard was set to indicate a certain figure, the larger illuminated dial in the fire room indicated the same figure, at the same time any change in the setting of the dial at the switchboard was accompanied by the ringing of a bell and the lighting of a lamp at the dial in the fire room. These signals continued to operate until reset, thus insuring the switchboard operator that the fire room had received the information.

In this manner, a positive warning was given the fire room of the time, size, duration and direction of the intended change in load. The result of the installation of the dials and the signal system has been the kindling of a spirit of co-operation—each knowing and understanding the moves of the other so that the operation of the entire plant is much smoother than before.

Man is naturally a thinker and the trait of training the eye to look for improvements and the mind to reason them out is one that may be acquired and one that will develop under the proper stimulation.

How much better it is to have an employe continually searching for some method to improve his work, continually on the lookout for betterments and improvements than to have him thinking of things far off from his work. It is under these conditions that he will give his maximum effort and produce the best results.

An organization composed of such employes, who are all on the lookout to improve conditions and methods, who are all working toward this one admirable end, is sure to be a harmonious and co-operative organization, whose members all feel that their efforts are appreciated and who feel that by the installation of a few successful ideas may have acquired a personal interest in the operation of the plant. CLAUDE C. BROWN.

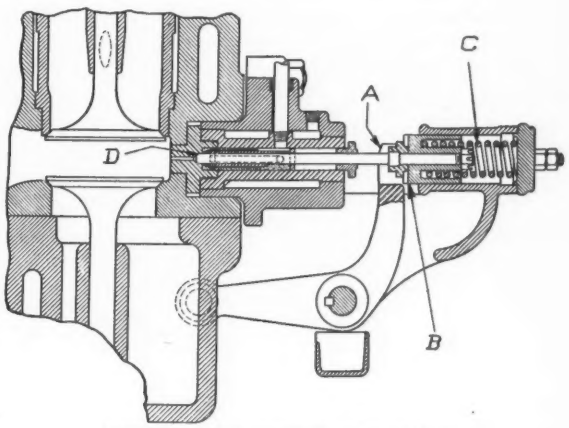
PASSING THE BUCK is a cowardly method of trying to cover a mistake.

Oil Engine Fuel Valve Sticks

IN THE July 1 issue of Power Plant Engineering, John Pierce, in describing a Diesel engine plant, made mention of an auxiliary spring that the engineer had put on the fuel valve. It was stated that the regular spring did not cause the push rod roller to follow the cam, and the roller jumped.

I do not deny that the extra spring which I suppose was hooked on in about the way shown in the accompanying figure, causes the push rod roller to follow the cam better. But the engineer or Mr. Pierce is wrong in saying that the regular valve spring would not give enough compression.

There is a clearance between the fuel valve bracket fork A and the spring cup B of the fuel valve. One can have the compression of the regular spring C so much that it is almost impossible to lift the valve, and still have the pushrod roller fail to stay against the cam. Spring tension has no effect except in extraordinary cases of weak spring, and if a spring is this weak



SECTION OF OIL ENGINE FUEL WASTE

the fuel valve will be forced and held open during the working stroke by the gas pressure on the needle valve D.

The real reason the push rod roller does not track on the cam is that the push rod passes through a stuffing box. If the packing gets hard, the rod will bend and as soon as the needle valve seats, the rod is no longer under pressure from the spring C, so it stops moving. This will hold the roller away from the cam until vibration, etc., causes the rod to drop on the cam.

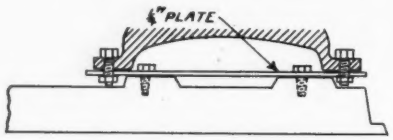
The remedy is to remove the stuffing-box gland and packing and then replace the gland. The rod is now free to move down by its own weight. It is also possible that the rod is slightly bent and rubs against the bottom of the stuffing-box. The remedy is to take the rod out and straighten it. M. S. HOWARD.

SWEDEN'S TOTAL supply of water power, estimated at approximately 7,000,000 hp., is available during about 9 mo. of the year and is exceeded among European countries only by Norway, which has an estimated available supply of 7,500,000 hp. Of the Swedish power available, only about 3,500,000 hp. are worth developing at the present time; of this amount, 2,800,000 hp. are privately owned and 700,000 are owned by the state.

Emergency Motor Base; Handy Tool for Starting Screw

WE RECENTLY purchased a motor driven service pump for use in one of our outlying country stations, and when the outfit arrived at the plant it was promptly set on the foundation and grouted in place, as it was essential to get it into service quickly. When the electrician ran his wires he noted that the motor was for three-phase current, while the only electricity available in the town was single-phase. A mistake had been made by the party taking the order, and we were in a bad hole. We got out of it, however, as follows:

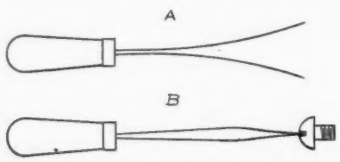
A single-phase motor was delivered the next day, and when it arrived it was found that due to its larger size it did not fit on the machined pads on the pump base, which pads had been laid out for a three-phase motor frame. It was imperative that we get the unit in service, and since it had already been installed, we accomplished the trick as shown in the accompanying



STEEL PLATE USED TO ENLARGE MOTOR BASE

sketch, from which it will be noted that we took a piece of ¼-in. steel plate of sufficient size large enough to hold the single-phase motor, and this plate we bolted down to the base securely by means of the four holding bolts originally intended for the three-phase motor. The single-phase motor was then bolted to the overhanging plate, as shown, and the outfit has been in service thus for several months and apparently is good for a long run. Such an alternative might be well to bear in mind in similar emergencies.

While being visited by a repair man, I noticed a peculiar looking tool in his kit, and upon making inquiry concerning it, he brought to my attention what seems to be a very useful little tool to have about the plant.



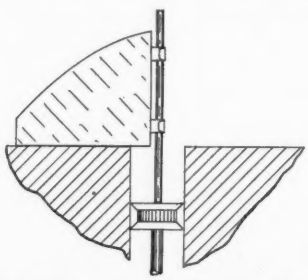
SCREW DRIVER FOR HOLDING AND INSERTING SCREWS IN INACCESSIBLE PLACES

The tool consisted of an ordinary tool handle into which were placed two pieces of spring steel, with the outer ends free and sprung away from each other, in the manner illustrated in the sketch, A. It was intended for starting screws in inaccessible or narrowly constricted places where one could not readily get his fingers in order to start the screw on its way. Sketch B makes the general scheme very clear—the two out-sprung ends are pulled together and put in the screw slot, and the tendency of the ends to open holds the screw firmly in place while it is being started into the hole, following which the use of an ordinary screw driver will finish the job. The occasions when an engineer has use for a tool of this kind may be remote, but the tool can be so easily and inexpensively made, and solves the problem in such a neat fashion, that it seems to justify a place in the tool kit. M. A. SALLER.

Small Depth Gage

THERE ARE many small jobs on which the ordinary depth gage is a somewhat inconvenient tool to use, and much less the method of utilizing two small scales or a straight strip to get small depths or lifts.

The sketch shows how an old tobacco can will afford a neat, practical home-made tool in a few minutes. The cover clips bent over the bit of wire forming the hinge



DEPTH GAGE MADE FROM TOBACCO CAN

are forced back, freeing the cover. With a small pair of snips a small portion of the body of the can is cut out with the hinge wire attached. These wire lugs are then loosened with a knife blade tip to allow the bit of wire to slip snugly up and down in the guides, formed by the opposite lugs. The lower face of the tin body or grip is cut square with the wire or stem. For a small practical tool, on work not requiring extreme accuracy this little makeshift will fit in a great many places where it would not be possible to do much, if anything at all, with the larger device. FRANK W. BENTLEY, JR.

Supporting Recording Instruments

IN BUILDINGS where the walls are supported by a timber foundation, and sometimes on a more solid one, the operator or engineer finds that the vibrations from

the factory machinery are transmitted from the walls or floors to the recording instruments through the supports or stands, such vibrations may cause a pressure recorder to show a difference as much as 5 lb. from the correct pressure, or a temperature recorder to be as many degrees to the bad.

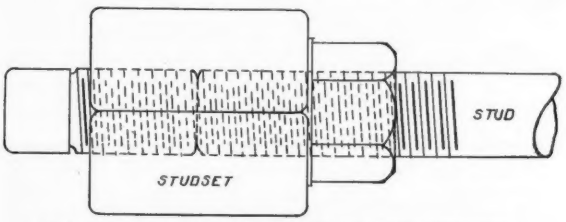
To stop all this vibration go to a stationery store and at a cost of 5 cents each secure a number of the soft, spongy, pencil mark erasers, such as draftsmen use to clean a drawing. These erasers are in cubes about one inch in diameter. Wherever a bolt or screw is used to attach or hold a recorder to a wall or on a stand or shelf or other support, use one of these cubes between the recorder and the support. Mighty easy, but it will invariably prove a cure. Ordinary dense rubber, leather pads, or springs, will not be in the same class in ultimate satisfactory results. Once every three months remove the old erasers and put in new ones.

JAMES E. NOBLE.

Method of Removing Studs

THE SKETCH shows how we backed out some studs after all other means had failed.

Neither two nuts locked together and the studset would not do the work alone, but by setting the studset

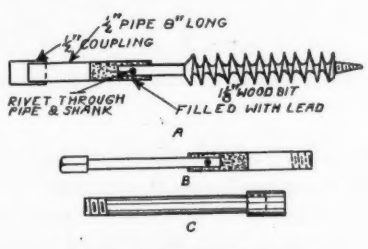


SHOWING NUT SET UP TIGHT AGAINST STUDSET

as tight as possible and locking a nut against it we were able to back the studs out. They were in a recess where it was impossible to get a pipe wrench on them and it would have been necessary to dismantle the machine to drill them out, so we were greatly elated at getting them out with so little trouble. J. O. BENEFIEL.

A Handy Extension Bit; Steam Trap on Damper Regulator

SOME TIME ago, there was an electrician in my plant installing light wires, etc. In drilling holes through which to run ½-in. conduit, he used an extension bit of the type shown in Fig. 1, made in the following way.



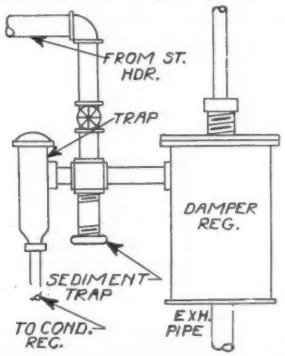
PARTS OF EXTENSION BIT

The shank on the bit is sawed in two, then that part with bit on it is placed in a ½-in. pipe about 8 in. long which has a coupling on the other end. The shank is held in the pipe by pouring lead around it, drilling a ¼-in. hole through the pipe and shank, and then passing a rivet through this. In the same manner, the other half of the shank which fits into a brace is fastened into another ½-in. pipe 8 in. long as shown at B. Then this pipe is screened into the nipple on the bit shank.

Should it be necessary to extend the bit shank still longer, the pipe with the shank is removed from the coupling and another piece of whatever length is required with a coupling on one end as shown at C. This piece of pipe is screened into the coupling on the bit shank, then the pipe with the other part of the shank is screened into the extension piece of pipe. In this way, the shank on the bit can be made to any desired length, and is also very rigid, and there is but little danger of breaking it.

I have found this quite handy in many instances. The bit illustrated is 1⅛-in. and the pipes used for the extension are ½-in.

My damper regulator is of the steam operated type and operates but little during the day's run, hence the steam pipe to the damper regulator fills with condensate and as the pipe furnishing steam to the regulator is quite long, it would take the regulator some time to operate when the steam was up to pressure. Frequently

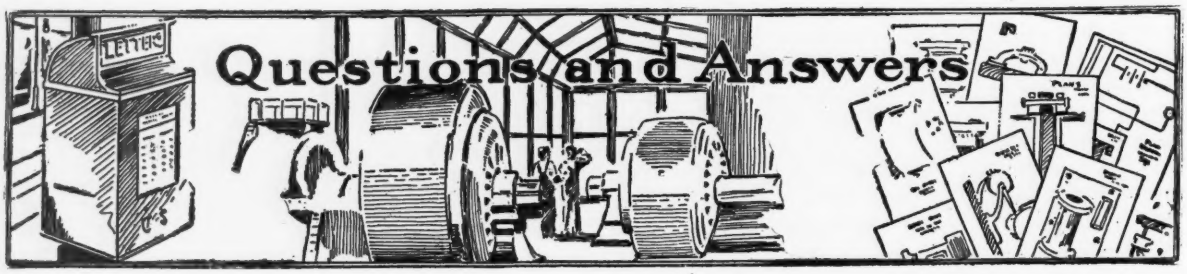


LOCATION OF TRAP ON DAMPER REGULATOR TO DRAIN STEAM PIPE OF CONDENSATE

the safety valve would blow off before the condensate would be removed out of the pipe and the damper regulator would operate to close the damper.

To overcome this trouble I connected a small steam trap to the regulator steam pipe as shown in the illustration, after which there was no further trouble with the damper not operating on time due to condensate in the steam pipe. The discharge from the trap is connected to the condensate receiver and is returned to the boilers, hence there is no loss. H. A. JAHNKE.

SEPTEMBER 4th, last, marked the 40th anniversary of the central station industry. Forty years ago—at 3 o'clock in the afternoon of September 4, 1882—the first central station went into operation. This was the Pearl St. station of the Edison Electric Illuminating Co. in New York City. Six steam boilers in the basement furnished steam to six engine driven generators on the second floor, each machine having a capacity of 125 hp. Forty years may seem a long stretch, yet when we compare this crude little station with the super power stations of today, we marvel at the rapidity with which the industry has developed, and the time element becomes insignificant.



Methods of Cleaning Steam Condensers

I WOULD like to know the most effective methods of cleaning steam condensers which have been employed by readers of Power Plant Engineering, how long the condenser must be out of service, what devices are employed, frequency of cleaning, what effect such cleaning has on vacuum or circulating water required.

W. M. M.

Change in Boiler Feed Piping

THE TWO accompanying diagrams show our present and revised boiler-feed water systems. As it is now, the pumps are a long distance from the boiler room, which is both inconvenient and wasteful. We would like to make one feed pump handle all the water for the boilers and eliminate the small return pump in the cellar.

Referring to Fig. 1, the boiler pump takes the water at 70 lb. pressure from the city main, and pumps it through the primary heater, which is heated by the exhaust steam from the main engine of 750 hp. before it passes to the condenser. From this heater it passes through a secondary heater that is heated with the exhaust steam from the boiler and condenser pump. The water passes then across the yard to the boiler. The returns from the heating system are collected in a small tank and pumped back into the boilers. This pump is in the engine room below.

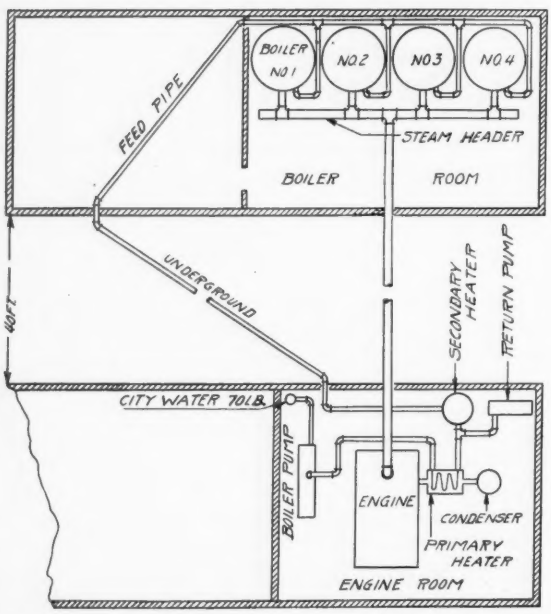


FIG. 1. FEED WATER PIPING AS AT PRESENT INSTALLED

According to the revised system, Fig. 2, city water at 70 lb. pressure passes from the water meter to the primary heater, through this to the large tank in boiler room. The boiler pump takes its hot water from tank and pumps it through the secondary heater, then to boilers. The heating system returns will be discharged into this tank and the small tank and pump in engine room below will be removed. Exhaust steam from the condenser pump will be run over to the secondary heater, as will also exhaust steam from boiler feed pump. Would such a change be advisable? J. B.

Fuel Oil Handling System

AT OUR plant, in which we use oil fuel, we are at present paying 2 cents a gallon haulage charge for our oil. I have recommended putting in a pipe line and pumping our oil direct from the railroad track to the plant, a distance of approximately 1800 ft. with a head of not over 5 ft. We use from 12 to 18 deg. Baumé oil at a mean temperature of 70 deg. F. As proposed, there will be about three bends in the pipe line.

I would appreciate advice as to the most economical size of pipe to use, the size and type of pump and the size of motor. The motor will use 110 v., alternating current. The capacity of the system need not be in excess of 6500 gal. in 8 hr.

My own plans call for a 6-hp., 3-phase 60-cycle motor, a 3-in. rotary pump and a 3-in. line. With this

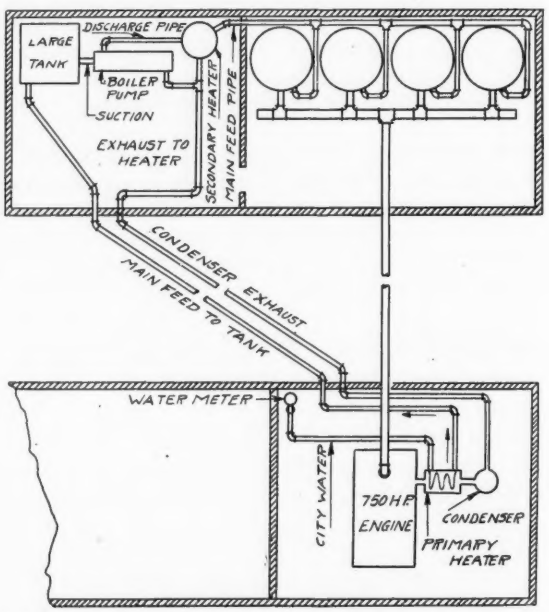


FIG. 2. PROPOSED ALTERATION IN BOILER FEED SYSTEM

arrangement, it would seem that the delivery charge ought not to be in excess of ⅓ cent a gallon. What is your opinion on this question? J. F. M.

Oil or Electricity

In an article entitled "Oil or Electricity" which appeared in the Aug. 1 issue, I note that a correspondent is anxious to know which would be better for him to use. I'd put in an oil engine, straight Diesel horizontal type. The comparison between cost of central station current and oil engine generated current will favor the oil engine by about 20 to 30 per cent, year in and year out. Everything considered, if oil costs 5 cents per gal., delivered at the plant, you can deliver power on switchboard for not exceeding 1⅛ cents per kw.-hr. All items are allowed for in this estimate: $50 to $60 a week for engineer, besides all items such as minor repairs, interest, taxes, depreciation, etc.

As I understand it the absorption machine is to be replaced by a motor driven compressor. With plenty of exhaust steam available for the absorption machine, I fail to see how he can come out in good shape on his monthly costs after the motor driven compressor takes up the load. His costs will soar. He will be surprised. Why not continue the absorption machine in use and add another unit to it? I've never seen a compressor yet that could beat the economy of the absorption machine if exhaust steam can be obtained as a by-product of power.

My advice would be as follows. Leave one 100-hp. boiler in condition for heating purposes, put in one 325 or 350-hp. Diesel engine, direct connected to a 3-phase, 60-cycle, alternating current generator; induction motors for all auxiliaries; and a synchronous motor to drive the new high speed compressor. This will maintain a good power factor on the system. The recommendation is made only in case it is considered impossible to retain the absorption machine.

If it can be retained, add a larger one of the same type to the installation. Use the large one during the warm weather and the small one in fall and winter. No doubt ice cream is made and low temperatures are required in the creamery for butter. If so, the absorption type is best for holding low temperatures. The boilers are not sufficient to carry the load. Install one more of 125 hp. or put in two 225-hp. water-tube boilers. One could be down for cleaning or repairs and other forced enough to pull the load. Up to 10 lb. back pressure could be carried on the exhaust system to supply the generators of the absorption system which would give them full capacity. I've carried full capacity with 3 lb., but the writer feels that to do away with an absorption machine and substitute a compressor is costly and will surprise anyone that tries it. D. L. Fagnan.

Oil Engine Burns Hole in Piston

Under the above title, in the Aug. 15 issue, page 813, L. B. asks a question as to what method may be used to prevent burning holes in the top of an oil engine piston.

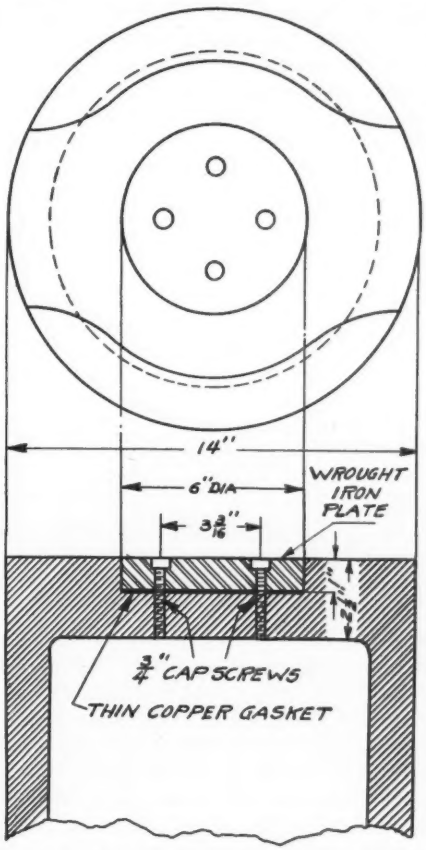
I once had this same trouble and the accompanying sketch will show the method that was used to prevent the trouble and it worked perfectly.

As the sketch will show, the head was counter-bored in the top to a depth slightly more than one inch and a thin copper gasket was inserted under the wrought iron plate, the plate being one inch thick and being drawn down with four ¾-in. cap screws, as tight as possible. The metal was then calked over the head of the screws to prevent any possibility of their working loose.

The idea was that as the wrought iron has a much higher melting temperature than the cast iron, the explosion temperature would not reach a point high enough to burn the wrought iron.

If the construction of the piston of which L. B. speaks is such that he can use the method as shown, I can assure him that he will have no more burned pistons.

It is well to have the counterbore made slightly larger than the diameter of the plate in order to allow for expansion; but care must be taken in a job of this kind, for if the bore should be much larger than the plate, or should be too deep, allowing the plate to drop in below the top of the piston, it will affect the clearance volume, thus reducing the power and efficiency of the engine. F. C. DeWeese.



METHOD OF REPAIRING PISTON TO PREVENT BURNING HOLES IN TOP

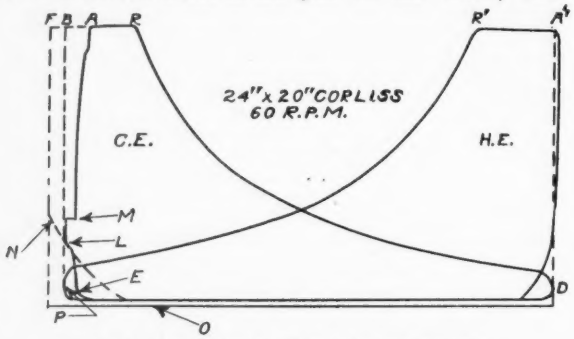
What Is Wrong With This Engine

With reference to the question on an indicator card, on page 727, July 15 issue of Power Plant Engineering, it is my opinion that the trouble lies not so much in the engine as in the indicator. The question refers to the peculiar knob on the compression and admission line. This being the crank end diagram, there

is little chance for any other cause than a short indicator cord, either between the reducing wheel and the crosshead, or between the reducing wheel and the drum on the indicator.

Referring to the accompanying figure: the drum turns enough to bring the pencil up against the clips holding the paper or the stop pin at the bottom. The compression runs up to L, where the indicator drum ceases to turn, and the compression then runs up in a straight line to just below the theoretical point at N. At this point the compression pressure holds the pencil, while the crank is passing over the crank end center. The spring is distorted and starts the drum turning back, making the horizontal line at M, while the steam valve moves to uncover the lap and give lead, when the admission occurs and raises the pencil up to the steam line. While this is occurring, the drum is turning and gives the curve to the admission line from M to A; but right here is the point which is confusing, for on this theory it would appear that the cord is too long as otherwise cutoff would occur later than at R.

To me it appears that there is more trouble with the indicator, because with a short cord there will be a distorted or broken spring on the reducing wheel or drum or a distorted tooth in the gear on the wheel, which



INDICATOR DIAGRAM FROM CORLISS ENGINE

would cause the drum to stick and make the short horizontal line at M after admission had taken place. If the indicator piston and cylinder were dirty, it would stick slightly at the beginning of the rise and the actual admission may occur at the point L. The cord being short, the piston would be going forward before the drum moved off the distorted tooth and then would shoot up on a leaning line to A, and this condition would account for the short steam line between A and R, the point of cutoff.

It is evident the engine piston travels some distance without much movement of the indicator drum, which is retarded by the stretching of the string or distortion of the spring. Theoretically the compression should begin at about the point O, rise to L or N, where admission begins and then rise to B or F. If the cord and indicator were in proper adjustment, this would give a steam line from F to R which would equal the length of the steam line R′ and A′ on the head end diagram.

While this kink may be due to the indicator, it is also a symptom of valve leakage. Place the engine on the crank end center and admit steam to that end while there is an opening in the exhaust pipe near the engine. If the valve leaks, steam will blow right through and out the opening.

I would make no changes in valve setting until I had put the indicator in perfect order, had made proper adjustments of the cord and reducing motion and had gone all over the valve setting and checked up every part to find out whether the engine or the indicator was at fault. Then, and not until then, adjustments may be made without risk of putting the entire valve setting in bad shape. R. A. CULTRA.

Engine Rating

IN THE Aug. 15 issue of your interesting journal, there is an inquiry as to the probable indicated horsepower of a compound engine, 10.25 in. by 18.5 in. by 12 in., 100 r.p.m. and 125 lb. gage pressure. It is answered, I presume, editorially, by a calculation showing that the i.hp., noncondensing, will be approximately 37.5 and condensing 62.8.

The calculation of the probable i.hp. of given engines, and the design of new engines have taken up considerable of the 26 yr. since I finished my engineering course in 1896, and these figures caught my eye at once, especially the large excess in power of the condensing over the noncondensing. Also, the calculation is needlessly long and complicated, especially the calculation of the two cylinders separately. I give you herewith the calculation as I have made it scores of times, and as anybody can do it with a handbook and a slide-rule, in a very few minutes.

I will assume, as you did, 25 per cent cutoff in the high pressure cylinder, also 5 per cent clearance, giving an actual cutoff $(25 + 5) \div (100 + 5) = 30 \div 105$ or 28.6 per cent = 3.5 expansions.

The cylinder ratio is $(18.5 \div 10.25)^2 = 3.25$.

The total expansion is then $3.5 \times 3.25 = 11.38$, equivalent to an effective cutoff, referred to the low pressure cylinder of 8.8 per cent.

If the absolute initial pressure is multiplied by the formula for isothermal expansion $(1 + \log_e R) \div R$, the result is the mean theoretical pressure on the steam side of the piston. It is not necessary to work out this formula, as most engineers' handbooks give a table of "mean pressure constants," so-called, that are amply close for this sort of work. From such a table (The "Mechanical World Pocket Diary and Year Book," 1914 Edition, p. 73), I take this constant for our case as 0.31. Then the mean forward pressure is $0.31 \times (125 + 15) = 43.3$ lb. This must now be reduced by the back pressure, which we will assume to be 17 lb. absolute, making a theoretical mean effective pressure of 26.3 lb.

This answer differs from original by the amount of diagram factor—80 per cent less.

The next step is easy enough, but requires judgment and experience. So far results have been pure theory. There are all sorts of losses, but they can all be lumped and taken care of by what marine engineers call a "diagram factor." Assuming ordinary conditions for such an engine, with some care taken in piping, jacketing, etc., this engine should have a diagram factor of about 80 per cent. Therefore, we multiply the theoretical mean effective pressure, 26.3 lb. by 0.8; the result is 21 lb., which is the approximate actual mean effective pressure of this engine, referred to the low pressure cylinder.

The area of low pressure piston is 268.8 sq. in. Then the indicated horsepower is i.hp. = P L A N; 33,000 = $2 \times 21 \times 1 \times 268.8 \times 100 \div 33{,}000 = 34.2$.

If the engine is to run condensing, we go back to the theoretical 43.3 lb., but for back pressure will deduct only between 3 and 4 lb., say 3.3 lb. This gives a theoretical mean effective pressure = 40 lb. Take the diagram factor again as 80 per cent, which here is a trifle optimistic, and the approximate mean effective pressure is now $0.8 \times 40 = 32$ lb. From which, as before, the indicated horsepower is 52.5.

My figures show yours to be favorable indeed, especially as to running the engine condensing. As a matter of fact, if I were asked about this engine by a client who was considering buying it. I would probably tell him that it was good for about 30 indicated horsepower on the atmosphere, and about 50 with a good condenser at about 26-in. vacuum. Please bear in mind that I am looking at this as a marine engineer, and 26-in. vacuum is all any marine man wants on his main engines, as any more usually means cold feed water, so there is no gain from a high vacuum on a reciprocating triple or quadruple engine. WM. S. AYARS.

EDITOR'S NOTE: It will be noted that the results submitted by Mr. Ayars differ from those originally presented by approximately the amount of the diagram factor, 80 per cent, which he has allowed. No such factor was taken into account in the original solution of this problem, largely because of the fact that it varies considerably with individual units.

Centrifugal Tension in Belting

THE ARTICLE entitled centrifugal tension in belts, in the issue of Sept. 1, page 876, gives an unsatisfactory explanation of the centrifugal force acting in transmission belts. The following statements are quoted from this article:

(a) "About the only effect that centrifugal tension has on the horizontal belt is to cause the belt to stretch and thereby it increases the arc of contact on the two pulleys."

(b) "—even in this vertical belt, practically the only effect centrifugal tension has is to stretch the belt." "If one would hang a chain or flexible cord over the upper pulley of the same length as the stretched belt it would occupy almost identically the same position."

(c) "At exceedingly high speeds, to be sure the belt will be weakened due to the centrifugal tension power or ability to pull, due to greater friction will probably be increased."

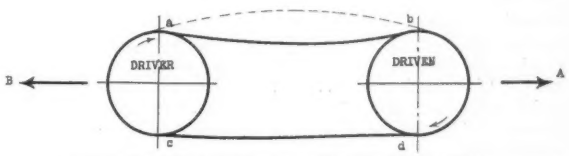
Referring to the accompanying figure, consider the driving pulley to be rotating at a high rate of speed. If this pulley could be split on any diameter the halves would fly apart. The force tending to make the parts fly in opposite directions is known as centrifugal force. This force is resisted by tension in the pulley rim and does not become apparent unless for some reason the rim is broken. Then we have the only too vivid examples in the records of wrecked plants and buildings caused by the so-called explosion of the flywheel.

It is not hard to see that when a belt is in contact with a pulley rim the belt is subject to the same laws as the rim itself. So that the portion of the belt between the tangent points a and c has a force acting which tends to throw the belt away from the pulley. Whatever the actual direction of the resultant of the forces acting, it is evident that there must be a horizontal component acting in the direction of the arrow B, because all of the belt that tends to leave the pulley is to the left of the line a-c. In like manner, that portion of the belt between b and d has a force acting in the direction of the arrow A.

Since these forces are opposite in direction, they cause a tensile stress in the belt between points a-b and c-d. This tension caused by the centrifugal force acting upon the belt is called centrifugal tension. This tension will have the same effect upon the belt as any other tension from any other source, therefore it will have its effect upon the sag of the belt.

The position taken by the slack side of a horizontal belt is not a segment of a circle, but approaches a catenary; this is true of both the tight and slack sides when the centrifugal force is not great enough to overcome gravity. If the speed of the belt were great enough, the belt would tend to conform to the arc of a circle, but this arc would be the reverse of the sag and the position would be that indicated by the dotted line.

Professor Goodman has shown very clearly that the effect of centrifugal force is to throw the belt away from the pulley. This decreases the arc of contact. This effect is most noticeable at the smaller of the two pulleys,



EFFECT OF CENTRIFUGAL FORCE ON BELTING

nevertheless a similar force acts at all pulleys. If the speed of this belt could be sufficiently increased, the belt would take the form of a circular band revolving about its center of gravity. (Compare with statement b.)

W. F. Schaphorst stated in his article of March 15, 1921, that the tension required to pull the load was 462 lb. Now we find that the centrifugal tension is 424 lb., or about one-half of the total tension in the belt. In other words, the belt must be twice as wide as it would have to be if there were no centrifugal tension.

A critical speed is reached in most belts at about 5000 ft. per min. By critical speed we mean the speed which if increased will decrease the amount of power that the belt will transmit.

The stretch of a belt caused by centrifugal force may be illustrated by the particular belt considered in the original article: a 12-in. by ⅜-in. belt having a sectional area of 4½ sq. in. Prof. Bird found that 20,000 lb. per sq. in. may be considered as a fair value for the modulus of elasticity of leather. The centrifugal tension we found to be 424 lb., or

$$424 \div 4.5 = 94.2 \text{ lb. per sq. in.}$$

This means that the stretch in the belt is $94.2 \times 12 \div 20{,}000 = 0.056$ in. per foot of length. It would require an unusual length between centers to make an appreciable increase in the arc of contact. M. B. CUTSHAW.

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What About Coal?

Now that the operators and miners have settled their differences and production is beginning to show signs of a return to normal conditions, the important question is whether to buy coal for immediate use only, or whether to buy for the future as well, and what price ought to be paid.

Indications are that the immediate demand for coal expected on resumption of operations has not materialized. In fact, during the middle of September there was a sharp break in prices as compared with quotations in August. For the Chicago territory, a good grade of mine run or screenings could be had for $3 to $3.25 a ton, as compared with $4.50 a ton two weeks previously. Lower grades were quoted around $2.50 a ton, all of these prices being f. o. b. mines, with an addition of about $1.90 a ton for delivery.

It is probable that this sharp break in prices was due to the fact that dealers had ordered large quantities on consignment with a view to making exorbitant profits. When the demand did not materialize, they were forced to break for cover. It is possible, therefore, that there may be some recovery and certainly the mine operators will use every effort to maintain prices so that the burden of the strike may be shunted onto the public.

With such fluctuations evident in the market, buyers of coal for power purposes can well afford to proceed cautiously. There is an excellent opportunity to shop around and pick up some bargains in spot coal.

From all of the information available, it would appear that the basis of procedure should be: use low grades which are on a competitive basis, insist on quality specified and watch the market.

The Eight-Hour Shift

Much has been said and written by publicists and social workers on the advantages of the eight-hour day in industry. Although the change to the shorter work-period has been made in many industries for humanitarian reasons, sufficient time has now elapsed for a direct comparison of results obtained under the different work-periods and this has been done by the Committee on Work-Periods of the American Engineering Council. As a result the committee reports that the two-shift day of twelve hours each is not an economic necessity. In fact, the report states that in most instances the production per man was higher with the eight-hour shift and a marked improvement in quality was also noted.

Many power plants throughout the country, particularly industrial and office building plants and small central stations, still hold to the twelve-hour shift and the managers will do well to consider reducing the working hours.

The benefits which will result from the lessened hours of work in power plants are principally intangible, they cannot be predicted and can only be estimated after an extended period of trial. What may reasonably be expected is increased efficiency from the plant, better morale and finer co-operation, reduced absenteeism and turnover of workmen, fewer accidents, a better class of men, both physically and mentally, will be developed and attracted to the plant, operation will be more uniform in results, attendants will be more vigilant and thus keep repair costs down with resultant longer life of machinery.

Surely such results are worth while and in most cases the extra cost will be more than paid for by the better quality of work and the increased efficiency of the plant.

Off Duty

As the evenings get longer and the chickens go to bed earlier and the garden calls for little attention, one has time to dream of the developments and future of power plants and to speculate on how our grandchildren will secure and distribute the tremendous amounts of power which their industries will demand if growth continues as in the past.

As to the fuel then available, one can be optimistic or pessimistic, according to his tendency and whose predictions he accepts. On the one hand we are told that oil and anthracite coal will have disappeared in 50 yr.; and on the other, are assured that the oil shales and undeveloped deposits of hard coal (not necessarily quite like Pennsylvania anthracite), are sufficient for an indefinite supply. But in either case they will not be sufficiently abundant to cut much figure in the total power required by, or even in the domestic heating for the second generation ahead. Bituminous coal is in sight in plenty for several centuries, but the cost of producing it is increasing as the more easily mined deposits are used up. And how we do waste it! Careless mining, destroying thin veins to get at thicker ones, beehive coking and using only 10 to 15 per cent of its energy. Looking ahead a thousand years, it's a good thing the cost of coal is going up to make us more careful and apreciative of its value.

And how will our successors generate and distribute? That depends so much on the distributing methods that we can speculate a lot. Super-power stations are in the lime light just now, but there the heating problem gets in the way. We cannot at present see any way to heat buildings economically except by burning fuel on the job; and when you have to do that, unless the power requirements are greatly in excess of the heating needs, it is but little more expensive to make high-pressure steam which can be run through an engine or turbine to develop power and use the exhaust for heating, than to make low-pressure steam for heating alone. Also, argument for the establishment of immense power plants at mines is hampered, except in a few special cases, by lack of sufficient water for condensing purposes; and if such plants must be located on large rivers to get condensing water, they may as well be placed where the most economical distribution system can be planned, for the extra cost of hauling coal a few hundred miles after it is loaded on cars is certainly not more than the total cost of distributing electrical energy over the same distance. Inter-connection of plants is, of course, desirable to the point of interchanging power so as to secure the best possible load factor, and especially to insure the using of all available power from hydraulic plants.

Perhaps the ultimate solution, which our thrifty-minded descendants will evolve, will be big plants for using the low grade screenings and mine refuse, processing plants for prepared sizes to save valuable byproducts, and block or district plants to furnish power, light and heat for cold months, the power and light for the months when heat is not needed to be taken from the big interconnected systems of transmission lines.

Other sources of power—tides, winds, waves and the sun heat—have been dallied with from time to time, and may have future possibilities. Unreliability of winds and the cost of controlling the tides and waves seem to put these out of the question. The sun power is enormous. Dr. Steinmetz says that if we could harness the sun heat that is wasted in the deserts of the United States, it would give a hundred times as much energy as all possible water powers plus all our present coal production. That makes it interesting; for in those desert regions, clouds interfere with the sunshine but little of the time, and there is no wild expenditure of enormous energy followed by utter stagnation as in the case of waves. The two great obstacles are: expense of gathering and using the sun heat; and the cost of transmitting the power.

There has been some suggestion that the broadcasting of radio will lead to wireless transmission of power, but our knowledge, so far, gives no reason for believing that we can do so. Waste of power in radio broadcasting is enormous, and unless some way is found to control the direction of sending and to prevent flow of energy except when the receiving switch is closed, as is done by wire transmission, even Dr. Steinmetz, who has foreseen developments which seemed improbable to less far-seeing men, does not think wireless power distribution can be a commercial proposition. Progress in transmission will come with the ability to handle higher voltages, with interconnection of systems to insure full load on all stations, and possibly with the use of hollow inductors through which a cooling fluid is circulated, thus lowering the resistance of the circuit.

Dr. Steinmetz, in an "off duty" talk, when he was not called on to counsel as to practical results, has said that, if we could unlock the stores of atomic energy, we could get from a pound of radio-active material energy equivalent to burning 1500 T. of coal. Our knowledge of this subject is so recent and so uncertain that he would be a daring prophet who would predict what our grandchildren may do along this line in the next hundred years. But certainly if the atomic energy ever is tapped, the ratio of 1 lb. to 1500 T. would seem to indicate a vest pocket size power plant, with some mighty careful handling of the "fuel supply."

Anyhow, it's an interesting occupation to dream of what may come, and as it won't change progress and doesn't cost anything except a little off duty time, it does no harm to speculate.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.

Develop Water Power Sites.

Promote Health and Safety in Power Plants.

Handle Coal and Ashes Mechanically.

Employ Engineers for Engineering Work.

Des Moines Entertains the N. A. S. E.

THE FORTIETH ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS HELD AT DES MOINES, IOWA

A YEAR has rolled by since the National Association of Stationary Engineers had last met at Evansville and it was with happy hearts and pleasant anticipations that the delegates to the fortieth annual convention arrived at Des Moines on Monday, Sept. 11, for this year's gathering. From the very start the convention gave promise of a much greater attendance than had at first been anticipated and over 800 delegates and guests were present at the formal opening. A hearty welcome was extended to the delegates by the local convention committee, and as fast as they arrived were escorted to the convention headquarters—of course, the band was there. You can just take our word for it, there was a great deal of handshaking and many pleasant renewals of friendships and acquaintanceships.

DELEGATES AND VISITORS AT DES MOINES (CONTINUED ON PAGE 975)

THE IOWA STATE CONVENTION

BEFORE GOING into a detailed account of the National convention, it will be well to touch upon the Iowa State convention which was also held at Des Moines on Sunday and Monday, Sept. 10 and 11. The first session of this convention was called to order at 10 a.m. on Sunday by State Vice-President Newkirk, who called upon National President Parry to address the convention. President Parry, among other things, stressed very strongly the value of the practical phase of engineering and warned the engineers to beware of becoming too technical.

The first order of business was the roll call of officers and delegates, showing all officers and 55 delegates present. Chairman Holdbrook of the license committee reported that nothing had been done during the year on account of no session of the legislature. In addition he reported that there was little prospect of getting any favorable legislation during the present year on account of the great amount of business before the legislature at this time. Considerable discussion followed the reading of this report.

National Secretary Raven, when called upon, made a plea for a more business-like management of funds of the national organization, stating that the items of education, license and propaganda were sadly neglected when compared to the income of the organization and the purposes for which it was conducted. He further stated that too great a proportion of the association income was devoted to the payment of mileage as compared to money spent for these other purposes. Quite a number of those present voiced the same sentiments.

The following officers were elected to carry on the work for the ensuing year: President, C. D. Sherman of Mason City; Vice-President Newkirk was re-elected. Abner Davis of Cedar Rapids was re-elected secretary and Jas. Coulson of Sioux City was re-elected treasurer. Conductor, Wm. Viggers of Des Moines; doorkeeper, Stoker of the new association in Ottumwa. Royal Holbrook was recommended for state deputy.

THE NATIONAL CONVENTION

THE PROCEEDINGS Monday consisted of registration of delegates and the opening of the mechanical exposition. The latter was held in the Coliseum in connection with the convention by the National Exhibitors' Association, and while it was not the largest display ever staged before the N. A. S. E. all the more important products were represented. The arrangement of the exhibits was in many ways superior to the arrangements of other years and a quiet dignity prevailed. The decorative and

lighting effects in the exhibition hall were particularly attractive, thanks to the splendid efforts of F. N. Chapman of A. Leschen & Sons Co., who is secretary of the National Exhibitors' Association.

At the formal opening of the exhibits, Clyde A. Bland, chairman of the convention committee, presided. Addresses of the National Exhibitors' Association officers, and by the president of the Association of Commerce were listened to with interest.

Following the addresses, a concert was given by a 25 piece band furnished by the Kansas N. A. S. E. state band.

On Tuesday Morning

THE CONVENTION was officially opened in the drill hall of the Coliseum. The presiding officer, Clyde A. Bland, introduced the speakers.

Following the invocation by Rev. F. C. McKean, the welcome to Iowa was tendered by Governor N. E. Kendall, who briefly outlined the good points of Iowa. Response to the Governor was made by Richard W. Parry, National President of the N. A. S. E.

The welcome to Des Moines was tendered by Mayor Garver, which was responded to by Frederick Felderman, National Vice-President of the association.

Other speakers at the formal opening were Geo. Hamilton of the Des Moines Chamber of Commerce, and Alfred Johnson, Past National President of the N. A. S. E.

The first order of business on Tuesday afternoon's program was the report of the credentials committee which indicated the attendance of 336 delegates. Next in order was the presentation of the reports of officers and committees.

The president in his report did not go into detail in regard to the finances, membership, etc., of the association, since those subjects were embodied in separate reports. The important question which the president brought up in his report was, "Why is the organization composed of some twenty-odd thousand members when it should be easily over a hundred thousand?" He urged that the report of the Membership Extension Committee be given very careful consideration, and strongly urged its adoption.

The educational activities of the national body, said President Parry, have not been producing the results warranted by the time, effort and money expended. Each local association is a co-operative school to give practical operating engineers an opportunity to keep abreast of the times and make up the deficiencies in their early education. The average age of the members is considerably over 35 yr. and in promoting the educational work, the members' sense of dignity must not be embarrassed; the members should therefore be permitted to select the particular methods of education whereby they will derive the most knowledge from their meetings.

DELEGATES AND VISITORS AT DES MOINES (CONTINUED ON PAGE 976)

In connection with the selection of the proper candidates in the election of officers, President Parry recommended that past presidents should be considered as available timber to serve again, at any time, as vice-president or president. He believed it wrong to create the impression that after a man has served one term in the office of president he is done. Continuity of service and effort of the right kind are essential to the success of any organization.

The national deputy, Fred Felderman, reported that according to reports sent in, the association had 19,259 active members. Attendance records throughout the year showed extremely low attendances of meetings. In the winter season when meetings are supposed to have a good attendance, the average was only 6.32 per cent. "What is the reason for this small attendance?" he asked. "Is it that we are in need of a change in policy?"

The treasurer reported total receipts for the year as being $79,556,44. Total expenditures were $44,462.96, leaving a balance on hand Aug. 31, 1922, of $35,093.48.

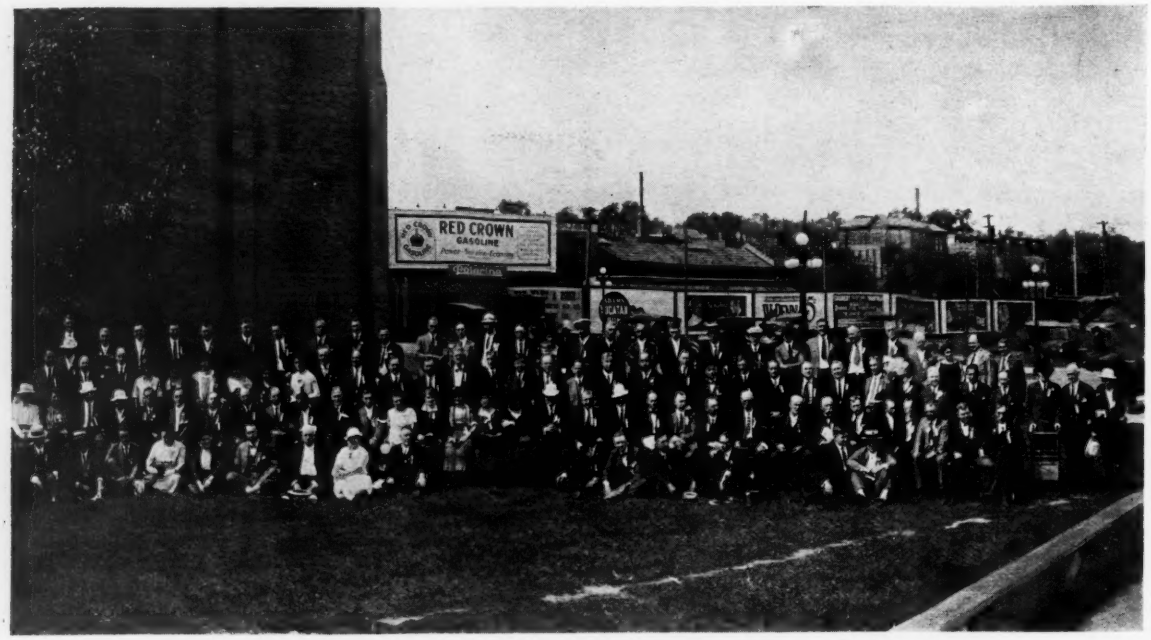
In building up membership, the Membership Extension Committee recommended greater co-operation between the various state associations and local bodies, the bulk of membership of which is composed of employers of power plant engineers or their employing representatives.

Following the business session Tuesday afternoon, F. S. Dunham, of the Permutit Co., delivered an illustrated technical lecture on the subject of recent developments in feed water treatment. The first part of Mr. Dunham's paper was devoted to a discussion of the developments in feed water treatment during the last 20 yr. In this discussion he described briefly the early intermittent water softener, the later development of water was treated for its lathering properties before and after softening.

WEDNESDAY

THE MORNING session convened at 9:05 with President Parry in the chair. The second report of the credentials committee indicated an attendance of 347 delegates.

Charles A. Cahill, of Milwaukee, addressed the convention on the subject of proposing a national law providing for each coal shipment from the mines being accompanied by a statement regarding the heat value of the coal, ash content, etc. John Knowles, of Pittsburgh, and others also spoke upon the subject. There seemed to be considerable divergence of opinion on this subject, and while the general attitude was that coal should be purchased on a B.t.u. basis, discussion centered upon where the analysis of the coal was to be made and by whom—the miner, the local dealer or the purchaser.



DELEGATES AND VISITORS AT DES MOINES

the continuous softener, the hot process softener, and finally the latest development, the zeolite softener which delivers water of zero hardness.

Records were shown from the plant of the Hammersley Manufacturing Co., of New Jersey, where the substitution of a zeolite process system for the old lime soda system resulted in a saving of $8000 a yr. for boiler cleaning, and the cost of chemicals was reduced from $307 to $176 a month. Tube replacements were practically eliminated while before from 10 to 20 new tubes had to be placed every month. The boiler plant comprised two 280 b.hp. water tube boilers and the water was taken from 16 artesian wells, the water varying in hardness from 7 to 16 grains per gallon.

The zeolite process, Mr. Dunham said, also finds a wide application in laundries and textile work. In laundry work it prolongs the life of linen, cuts down the amount of soap used and other supplies at least 50 per cent. The lecture was concluded by an actual demonstration of the zeolite process in which Des Moines city

While a number of the delegates were of the opinion that coal should be analyzed and labeled by the mine operator at the mines in much the same way that food products are required to be labeled under the requirements of the pure food law, others pointed out the shortcomings of such proposed practice. Owing to exposure in transportation and because of the fact that coal from various production centers is often pooled at transportation centers, the value of any analysis made at the mines would be rendered useless. It was also pointed out that any such law compelling the mine operators to analyze and label every car of coal put out would result in a further increase in the cost of coal.

The foregoing discussion was followed at 10:30 by a welfare paper on "Dry Rot in Associations" by Charles H. Bromley, of Fort Wayne, Ind. In his remarks Mr. Bromley pointed out that the causes of this condition in associations could be traced to taking up too much time with routine business details that could just as well be taken care of by the officers and the

various committees; domination of the association by perennial office holders who continue in the same rut year after year; lack of new ideas in the education program; the same old threadbare subjects being discussed year after year and lack of system in mapping out a yearly program.

To remedy this condition Mr. Bromley suggested that as much as possible of the routine details be eliminated from the proceedings of the meetings. Particular attention should also be given to interesting the younger members of the association. Arrange topical discussion that will bring into the discussion the greatest number of members. Insist on the president learning the order of business so that he can conduct the meeting without referring to the printed order.

Officers should be elected who will take an active interest in the work of the association. Because a member is an excellent engineer is no guarantee that he will make an efficient officer and members should take this into consideration when selecting their officers.

Shortly after adjournment of the Wednesday morning session at 11:50, everybody piled aboard special street cars for the State Fair grounds, and Wednesday afternoon all thoughts and worries of business were laid aside. And what a great day it was. Even the slight shower which occurred at noon did not dampen the ardor of the crowd. By the time the fair grounds was reached, the weather had brightened and all indications gave promise of one of the biggest and most successful outings ever had.

After the eats—and you can take it from us, they were some eats; not merely an anæmic looking sandwich with a cup of coffee, but everything one could ask for, and all one could eat—the first thing on the program was the annual baseball game between engineers and the exhibitors. Contrary to usual custom, however, the game this year went to the exhibitors with a score of 15 to 0 in their favor. The reason for this almost unprecedented occurrence of I. W. Bready, of the Permutit Co., who was pitcher for the exhibitors. He proved entirely too strong for the engineers, although at one time he did allow an engineer to get to first base. Fred Raven and Jack Armour acting as umpires provided considerable comedy.

The baseball game was followed by various other athletic events, including a fat man's race, potato race for women, a tug of war, a sack race for men, and a shot put for the engineers. In the tug of war the engineers came out as winners.

In the Coliseum at 8 o'clock Wednesday night an excellent entertainment was staged by the National Exhibitors' Association which was enjoyed by all. The entertainment was composed of the following numbers: Overture—Courtesy of National Exhibitors' Association; Chief Little Bear, Indian Songs and Dances—courtesy J. B. Ford Co.; Wyatt Bros., negro melodies—courtesy Chapman Valve Co.; Kaye Paulus, magician—C. F. Bowser Co.; Johnnie Dawson, song and dance—courtesy the Lunkenheimer Co.; Miss Claudius Tracy, Way Down East—courtesy The Johns-Pratt Co.; Jack Armour—courtesy Power; Hapac Grotto Quartette, The Cat's Whiskers—courtesy Jenkins Bros.; Madame Fatamie—courtesy Jointless Fire Brick Co.; four-round boxing bout (Kid Stubbs-Battling Gibbs)—courtesy Dearborn Chemical Co. Program arranged by Paul Payne.

THURSDAY MORNING

THE CONVENTION convened at 9 o'clock with the first order of business as the official roll call to verify the mileage list.

The committee on resolutions reported favorably on the proposal to ask the Federal Government to compel the coal shippers and jobbers to attach to all bills of lading an analysis of the coal showing the percentage of combustible, non-combustible, sulphur, moisture, together with the B.t.u. per pound of coal; the national president to be instructed to initiate such action as may be necessary for the enactment of such legislation. This report was approved by the convention.

Thomas G. Thurston next presented a paper, entitled "The Business of Power Plant Engineering."

In this paper Mr. Thurston discussed the fact that the engineer in charge of a power plant must always consider that plant in the light of a revenue producer. To obtain the desired action on the part of the owners or superior officers the engineer in charge must present his case from a commercial standpoint. The owners, Mr. Thurston pointed out, are only conversant in a minor way with the technical details of engineering and are as a rule not so much interested in technical detail as they are in the commercial end. The power plant to them is generally only a means to an end—the making of money—and it is from this angle that the man in charge of a plant will get the greatest co-operation from his superiors in the management of the plant.

It is all well and good to talk of thermal efficiency, increased ratings, etc., but the thing that is of real importance is the question of actual reduction in total operating costs—after all charges are paid. The test in every case is how much will it cost and how much money will it make? Here is where the business ability of the engineer is put to the real test.

No business man, said Mr. Thurston, attempts to conduct his business without some system of bookkeeping to keep a record of all transactions. The power plant engineer, if he wants to operate his plant on a business basis, will have to do the same.

The necessary records for the power plant can be classified into two major divisions—operating records and cost records. The engineer should be intimately familiar with each of these records and keep in mind at all times the effect of the operating record on the cost record.

In concluding his lecture Mr. Thurston touched upon the matter of management of superiors. Superiors are susceptible to management as well as subordinates, but by different methods. Superiors, like other people, will listen more readily to those they consider their equals and for this reason the engineer should conduct himself in speech, dress, and manner as far as possible like those his superior considers his equal.

Next in order on the program was the report of the mileage committee who reported the total mileage of delegates as 293,779. A 10 cent mileage was voted, meaning an expenditure for mileage of $29,377.90.

After lunch, the afternoon session convened at 1:45. Following the report of the ways and means committee and its adoption of the budget which it presented, John W. Lane presented a welfare paper entitled, "The Power Plant Engineer as a Specialist—Is It Being Overdone?" This paper dealt with the question of

proper classification of engineers—whether as a specialist or as an all around engineer. Shall the power plant engineer be satisfied to be a specialist in his line to the end, or will he aim to reach the higher positions in industry and enterprise? The paper was briefly discussed by various members who differed considerably in opinion as to the correct use of the term specialist as applied to the power plant engineer.

The last thing on the afternoon's program was the presentation of flags to associations having made a membership gain of 10 or more during the year. The session adjourned at 3:30 to meet at 9 a.m. Friday.

Friday

Friday the breaking up day of the convention is always the busiest day of the national convention and this time it was no exception. Business commenced promptly at 9 o'clock with the reports of committees and the disposal of unfinished business. This was gone through in short order and by 9:40 they were ready for the big event of the convention—the election of officers for the coming year.

In accordance with established custom the vice-president was elected president for the coming year by unanimous vote. This was Frederick M. Felderman, of New York.

The selection of the new vice-president, however, was not so easily accomplished. Four candidates were proposed: Holdbrook, of Iowa; Gielow, of Illinois; Kimball, of Massachusetts, and Burgess, of Michigan. Altogether five ballots were taken. After the first ballot, however, Burgess withdrew and during the next four ballots the fight was between Holdbrook, Gielow and Kimball. Holdbrook was finally elected in the fifth ballot.

Election of the remaining officers followed, after which the convention city for 1923 was voted on. Next came the announcement of time and payment of mileage to delegates and finally the installation of officers.

New Officers

The officers of the N. A. S. E. for the coming year are as follows: President, Frederick M. Felderman, of New York; vice-president, Royal H. Holdbrook, of Iowa; secretary, Frederick W. Raven (by unanimous vote); treasurer, Sam Force; national trustee, Wm. A. Reynolds, of New Jersey (re-elected for 5 yr.); conductor, Bart Doyle, of Connecticut; doorkeeper, C. A. Gordon, of Alabama.

The convention city for 1923 decided upon is Buffalo, New York.

The annual election of officers for the National Exhibitors' Association was held Thursday afternoon, Sept. 14, resulting as follows:

President, Hudson Dickerman, of the Johns-Pratt Co., Hartford, Conn.; vice-president, A. W. France, of the France Metallic Packing Co., Philadelphia, Pa.; treasurer, Geo. R. Rowland, of the Texas Co., New York City. Executive committee: E. E. Jones, of the U. S. Rubber Co., Chicago, Ill.; Wm. P. Lyons, of Johns-Manville Co., Chicago, Ill.; Charles F. Green, of the Home Rubber Co., Trenton, N. J.; I. S. Pieters, of Jointless Fire Brick Co., Chicago, Ill.; W. L. Schaeffer, of National Tube Co., Pittsburgh, Pa.

The officers and executive committee appointed as secretary F. N. Chapman, of A. Leschen and Sons Rope Co., of St. Louis, Mo.

The Exhibitors

Among those having exhibitions of steam power plant equipment and supplies were the following:

Allis Chalmers Manufacturing Co., Milwaukee, Wis.
Anchor Packing Co., Philadelphia, Pa.
Anderson Co., Ray M., Des Moines, Ia.
Arrow Boiler Compound Co., St. Louis, Mo.
Auburn Foundry Corporation, Auburn, Ind.
Baker Ice Machine Co., Omaha, Neb.
Bowser Co., S. F., Fort Wayne, Ind.
Brooks Oil Co., Cleveland, Ohio.
Bureau of Industries, New York, N. Y.
Bussman Manufacturing Co., St. Louis, Mo.
Chicago Engineer Supply Co., Chicago, Ill.
Chicago Faucet Co., Chicago, Ill.
Chicago Fuse Manufacturing Co., Chicago, Ill.
Chicago Metallic Packing Co., Chicago, Ill.
Cochrane Engineering Co., Chicago, Ill.
Cokal Stoker Corporation, Chicago, Ill.
Combustion Engineering Corporation, New York City
Conveyors Corporation of America, Chicago, Ill.
Crandall Packing Co., Palmyra, N. Y.
Crane Co., Chicago, Ill.
Crane Packing Co., Chicago, Ill.
De Laval Steam Turbine Co., Trenton, N. J., and New York City
Dearborn Chemical Co., Chicago, Ill.
Des Moines Electric Co., Des Moines, Ia.
Des Moines Gas Co., Des Moines, Ia.
Detrick Co., M. H., Chicago, Ill.
Diamond Power Specialty Corporation, Detroit, Mich.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Dunham Co., C. A., Chicago, Ill.
Economy Fuse & Manufacturing Co., Chicago, Ill.
Edward Valve & Manufacturing Co., East Chicago, Ind.
Electric Equipment Co., Des Moines, Ia.
Electrical Engineering & Construction Co., Des Moines, Ia.
Elliott Co., The, Pittsburgh, Pa.
Ellison, Lewis M., Chicago, Ill.
Engineering World, The, Chicago, Ill.
Federal Gauge Co., Chicago, Ill.
Fisher Governor Co., Marshalltown, Ia.
Flexible Steel Lacing Co., Chicago, Ill.
Ford Co., J. B., Wyandotte, Mich.
Foster Engineering Co., Newark, N. J.
France Packing Co., Tacony, Philadelphia, Pa.
Garlock Packing Co., Palmyra, N. Y.
General Electric Co., Schenectady, N. Y.
Globe Machinery & Supply Co., Des Moines, Ia.
Goodyear Tire & Rubber Co., Inc., Akron, Ohio
Green Engineering Co., East Chicago, Ind.
Green Fire Brick Co., A. P., Mexico, Mo.
Greene, Tweed & Co., New York City
Hawk-Eye Compound Co., Blue Island, Ill.
Home Rubber Co., Trenton, N. J.
Hulson Grate Co., Keokuk, Ia.
Hurtz Co., L. H., Des Moines, Ia.
Jenkins Bros., New York City
Johns-Manville Co., Inc., The, New York City
Johns-Pratt Co., Hartford, Conn.
Jointless Fire Brick Co., Chicago, Ill.
Keystone Lubricating Co., Philadelphia, Pa.
Kidwell Boiler & Engineering Co., Milwaukee, Wis.
Lagonda Manufacturing Co., Springfield, Ohio
Leschen & Sons Rope Co., A., St. Louis, Mo.
Libby Glass Manufacturing Co., Toledo, Ohio
Liberty Manufacturing Co., Pittsburgh, Pa.
Liberty Oil Co.
Liptak Fire Brick Arch Co., Minneapolis, Minn.
Liptak, Michael, Minneapolis, Minn.
Locke Regulator Co., Salem, Mass.
Lunkenheimer Co., Cincinnati, Ohio
Mac Whyte Co., Kenosha, Wis.
Manning, Maxwell & Moore, New York City.
Marshalltown Manufacturing Co., Marshalltown, Ia.
McCullough Manufacturing Co., Minneapolis, Minn.
Monash-Younker Co., Chicago, Ill.
Murray Iron Works Co., Burlington, Ia.
National Engineer, Chicago, Ill.
National Tube Co., Pittsburgh, Pa.
New Era Metal Products Co., Kalamazoo, Mich.
Northern Equipment Co., Erie, Pa.
Ohio Injector Co., Wadsworth, Ohio
Otis Elevator Co., New York City
Percival Co., C. K., Des Moines, Ia.
Permutit Co., New York City
Perolin Company of America, Chicago, Ill.
Powell Co., The Wm., Cincinnati, Ohio.
Power, New York City
Power Plant Engineering, Chicago, Ill.
Power Specialty Co., New York City and Chicago, Ill.
Philadelphia Grease Manufacturing Co., Philadelphia, Pa.
Pioneer Rubber Mills, San Francisco, Cal.
Quaker City Rubber Co., Philadelphia, Pa.
Reading Steel Casting Co., Inc. (Pratt & Cady Division), St. Paul, Minn.
Reliance Gauge Column Co., Cleveland, Ohio
Republic Flow Meters Co., Chicago, Ill.
Richardson-Phoenix Division, S. F. Bowser & Co., Fort Wayne, Ind.
Richardson Scale Co., Passaic, N. J.
Roebling's Sons Co., John A., Trenton, N. J.
Roto Co., The, Hartford, Conn.
Scully Steel & Iron Co., Chicago, Ill.
Shafer Oil & Refining Co., Des Moines, Ia.
Sloan Valve Co., Chicago, Ill.
Southern Engineer, Atlanta, Ga.
Springfield Boiler Co., Springfield, Ill.
Squires, Co., C. E., Cleveland, Ohio
Texas Co., New York City
United Machine Manufacturing Co., Canton, Ohio
U. S. Rubber Co., New York City
Vacuum Oil Co., Chicago, Ill.
Viscosity Oil Co., Chicago, Ill.
Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
York-Allen Ice Machine Co., Omaha, Neb.

Automatic Reclosing Equipment

IN ORDER to protect electrical apparatus from injury in cases of short circuit or severe overloads, the General Electric Co. has recently developed two types of automatic reclosing equipment, one for use on direct current circuits of 300 and 600 v., and the other for use on alternating current circuits. These equipments are designed to furnish protection by disconnecting the load from the station when any disturbance occurs, automatically connecting the two again after a predetermined time. As the operating features and design of the two types of equipment differ from each other, each type will be described separately.

The Direct Current Equipment

THE DIRECT current reclosing equipment is designed for use on circuits employing stub end feed, a combination of stub end and multiple feed, or, in combination with a sectionalizing switch, or sectionalized feeder.

The operation on stub end feed, where there is only one source of power to the load is typical, and its description will serve to give an idea of how the apparatus

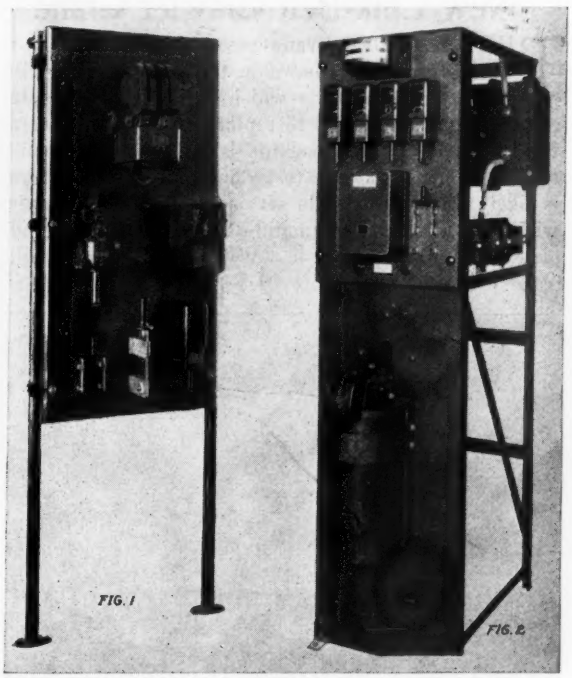


FIG. 1. DIRECT CURRENT AUTOMATIC RECLOSING EQUIPMENT
FIG. 2. AUTOMATIC RECLOSING EQUIPMENT FOR ALTERNATING CURRENT SERVICE

functions. The devices that go to make up the equipment are: a shunt contactor, an instantaneous overload relay, a reclosing relay, a control power switch, and a load indicating resistor. These devices are connected in accordance with the wiring diagram, shown in Fig. 3.

The sequence of the operation of the equipment in case of short circuit or heavy overloads on the feeder is as follows: The overload relay opens its contacts, deenergizing the coil of the contactor, which opens, disconnecting the load from the source instantaneously. When the contactor opens, it closes auxiliary switch (b) which energizes the coil of the time delay circuit closing relay, which starts to close. The time delay is inserted at this point in the sequence in order to allow conditions on the feeder to become stable. The closing of this relay completes the circuit through the lower coil of the reclosing relay,

The reclosing relay has two coils, and, to operate, must have both of them energized. Its operation somewhat resembles that of a voltmeter, the lower coil being analogous to the permanent magnet of the meter, and the upper furnishing excitation to the movable element on which the contacts are mounted. The relay contacts will close only when the voltage drop across the load,

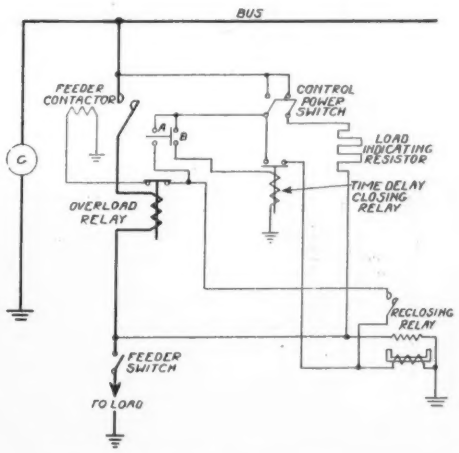


FIG. 3. WIRING DIAGRAM FOR DIRECT CURRENT RECLOSING EQUIPMENT

with which the upper coil is in parallel, is enough to cause the coil to excite the movable element sufficiently to close them. When the load resistance is zero, as in case of a short circuit, there is no voltage across the upper coil; but when the load resistance is infinity, or open circuit conditions exist, there is practically full voltage across the upper coil, because its resistance is so much greater than that of the load indicating resistor. Therefore it is possible to obtain an intermediate point, and calibrate the reclosing relay so that with a definite value of resistance in the load indicating resistor the equipment will not close on a load in excess of a predetermined value.

As long as the trouble on the feeder continues, the reclosing relay will remain open, even after the time delay relay has closed, because the voltage across the load is not enough to close the contacts. As soon as the trouble has cleared, and the load resistance has passed the predetermined point, the relay will close, energizing the coil of the feeder contactor, which closes, closing the auxiliary switch (a) which seals it in. The closing of the contactor reconnects the load, and de-energizes the time delay relay, which opens its contacts.

The automatic reclosing equipments are especially valuable in mine installations, for use on circuits supplying power to hoists, cutting and drilling machines, mine trolley systems, etc., in industrial plants, and on street railways. The automatic character of the reclosing apparatus eliminates delays that might arise from the necessity of reconnecting the load manually.

The Alternating Current Equipment

The alternating current apparatus is designed to protect station apparatus from trouble occurring on distribution lines. Two types have been developed for indoor and outdoor installation respectively and are designed for 2300, 4400, 6600, and 13,200 v. for both classes of service.

The apparatus itself consists of a number of standard relays operating in connection with an oil circuit breaker, which is closed by a small motor. The complete equipment for indoor service in capacities up to 7500 v. is mounted on a self-supporting steel framework.

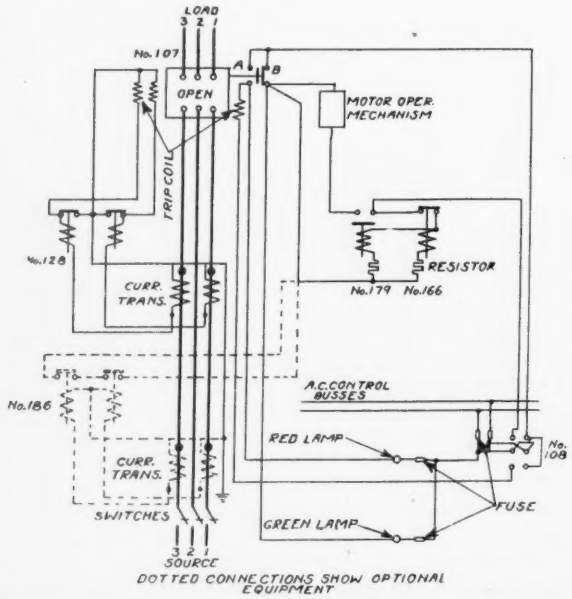


FIG. 4. WIRING DIAGRAM FOR ALTERNATING CURRENT TYPE OF RECLOSING APPARATUS

For voltages above 7500, the panel is mounted remote from the breaker. The outdoor equipment is made in two varieties, one with both the panel and the oil circuit breaker mounted together in a weather-proof steel housing, and the other using an outdoor type of breaker with the relay panel carried in a housing mounted on the supporting framework of the breaker.

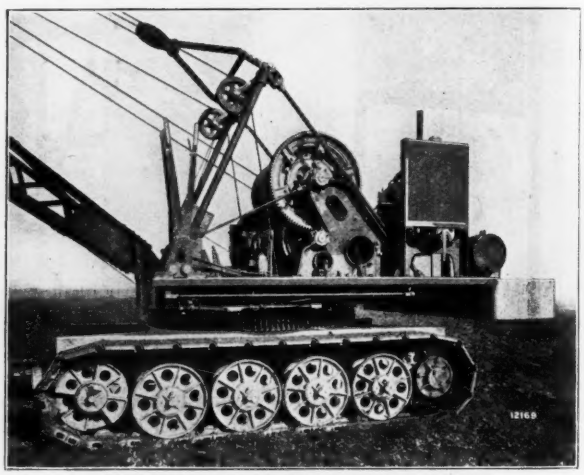
The apparatus used to make up these equipments and their method of operation are best understood by referring to Fig. 3, a typical wiring diagram. In practice, the circuit breaker is normally closed, the contacts of all relays except the reclosing relay, No. 179, being also closed. When a short circuit or overload beyond the setting of No. 128 (the overload relay) occurs, this relay operates with an inverse time characteristic and trips out the oil circuit breaker. The opening of the breaker closes auxiliary switch (b) energizing the reclosing relay No. 179 and the notching relay No. 166. After a definite time interval, the former closes its contacts and starts the motor which recloses the oil circuit breaker. At the same time, the notching relay moves up a step, and will begin resetting as soon as the breaker closes.

If the trouble has not cleared from the line by the time the breaker is closed, the overload relay will open it again, and the same cycle will be repeated, the notching relay moving up another step. If the trouble still continues, the breaker will open a third time, and further automatic operation of the equipment will be prevented by the notching relay, which opens its contacts on the third step, and must be reset by hand. The circuit shown by the dotted lines is a further protection which may be incorporated if desired, and which locks the breaker open in case of severe short circuits that are beyond the interrupting capacity of the oil circuit breaker. By throwing the control switch No. 108 to the down position, the breaker is tripped, and cannot be closed with the switch in that position. This feature assures the safety of anyone inspecting the breaker and equipment. Throwing the control switch to the upper position resumes the automatic operation of the breaker.

These equipments should be of value to power stations having isolated loads at widely dispersed points, the power for which is obtained either from tapping the main line or through a transformer substation. The reclosing feature insures continuity of service to the user of power, under normal conditions, and at the same time is a reliable protection to the apparatus of the main line in case of disturbance at the load.

New Link-Belt Crawler Crane

THE CRAWLER crane recently produced by the Link-Belt Co. is shown in the accompanying illustration. The crane which is of light but sturdy construction is designed to replace the locomotive crane for light work. The machine is built on a caterpillar frame so that it is able to go any place where a crane is likely to be called into service. It weighs, complete, without bucket, approximately 22 T., making a ground pressure of 10 lb. per sq. in. With the size of caterpillar tread provided it will lift 10 T. at a 12-ft. radius and



THE NEW LINK-BELT CRAWLER CRANE

3 T. at 30-ft. radius. The hoisting speed is 125 ft. per min., with a maximum rope pull of 10,000 lb. on a single line. The machine is provided with two independent hoisting drums so that it is suitable for either clam shell or drag-line bucket work. The crane is capable of making 4 r.p.m., traveling ¾ mi. per hr. and of climbing a 20 per cent grade.

The design has been simplified as much as possible so as to reduce maintenance to a minimum. There are, for instance, only 16 gears in the whole mechanism

instead of some 30 or so on the usual locomotive crane. The boom is 35 ft. long and is made of angle and lattice bar construction and is unusually strong for its weight. The crane is designed to operate in congested places and to this end the steering mechanism is built to turn the machine in its own length (10 ft. radius).

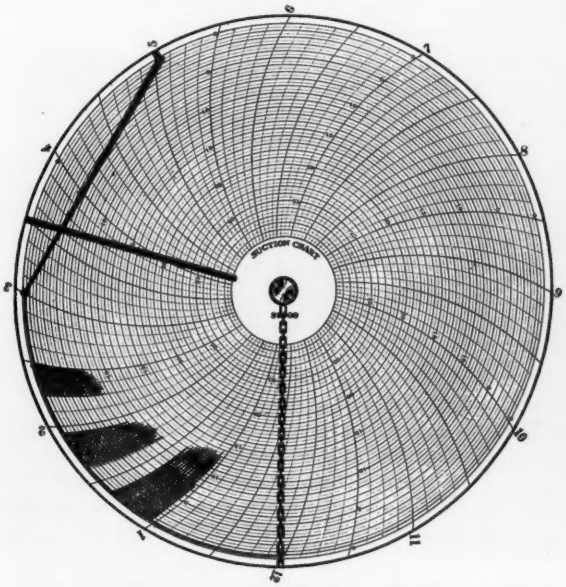
Power is provided by a 50-hp. Climax Engineering Co. gasoline engine, four-cylinder, 5½ by 7 in. heavy duty tractor type, running at 800 r.p.m. The fuel consumption on a test amounted to 25 gal. of gasoline in 11 hr., handling from 300 to 400 yd. of material with a light ¾-yd. bucket.

Remote Control for Steam Jet Ash Conveyor

UNCERTAINTY of steam consumption of steam jet ash conveyors has led the Green Engineering Co., East Chicago, Ind., to develop a remote control feature which measures the steam and controls the human element in operating the steam jet system.

Briefly this remote control consists of an electrically operated steam valve; a steam operated water valve and an air flow meter with a clock and chart.

When ready to hoe ashes into the intake, the operator puts his foot on a button or board and closes an electric switch with his foot. The closing of this switch operates a solenoid in the steam valve leading to the steam jet nozzle. The solenoid opens the steam valve. Located between the steam valve and the steam jet nozzle



SUCTION CHART FROM STEAM JET ASH CONVEYOR SYSTEM OPERATED BY REMOTE CONTROL

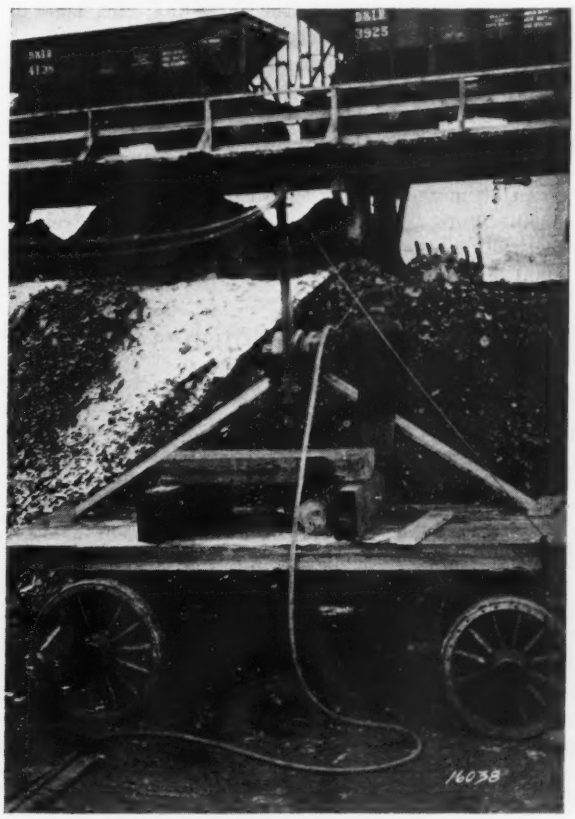
is a steam line which connects the main steam line to a water spray nozzle. Pressure of steam in this steam line opens the water valve and the water spray functions.

As soon as the operator lifts his foot, the switch opens automatically; steam pressure closes the electric valve, and the water valve closes because of lack of steam pressure.

The air flow meter gives a permanent record of the minute by minute suction maintained on the system. It tells the story if the operator lays a brick or stone on the switch and permits the steam to flow while he is not hoeing ashes into the system. This is shown by the nature of the line drawn on the chart. While the system is in proper operation, the pen will record jagged lines. When no ashes are being moved, the line will be straight along the curvature of the chart.

Mechanical Methods Applied to Grading Coal Piles

ONE of the large iron mining companies in the Lake Superior District was fortunate in finding available a year's supply of coal. Storage facilities were not sufficient to stock such an amount, so it was a question of enlarging the coal dock or piling the coal in such a manner that it could all be stored on the existing



COMPRESSED AIR HOIST USED TO GRADE COAL PILE

dock. This was done by grading the pile, at first using hand methods and later using mechanical methods.

Coal is dumped below the trestle and must be graded off to allow more to be dumped. Twelve men were used for this work, six on each side of the trestle, when it was being done by hand shovelers. Someone suggested that they use an Ingersoll-Rand Little Tugger hoist with a drag scraper for doing this work. This scraper outfit is used extensively to haul and load ore and rock underground in the mines.

The machine shown in the photograph is a small,

compact, double drum hoist which develops 7 to 8½ hp. on 60 to 80 lb. air pressure. One of the drums was called the haulage drum and the other, the tail-rope drum. When one drum is engaged, the other runs free. The haulage rope is laid from the drum directly to the front of the scraper. The tail-rope is led from the drum to a snatch block or sheave mounted conveniently behind the coal pile, and is attached to the back of the scraper by a clevis. In this way, one man can operate the scraper in both its forward and backward motions and so do all the work.

Nickel Alloy Soot Blower Element

BECAUSE of the extremely high temperatures to which soot blower elements are subjected, depreciation is heavy and maintenance costs are likely to be high. To obviate this difficulty, various methods have been employed to provide protection for the nozzles. Among these methods are water jacketing, heat treatment of the elements, cast iron sheathing, etc., none of which has proved completely successful.

As a further step in perfecting these elements, the Vulcan Soot Cleaner Co., Du Bois, Pa., has recently brought out a special non-ferrous heat resisting nickel alloy, called Vulcan-Hardite, which is resistant to oxidization at high temperatures. When cold this material has an ultimate tensile strength of about 80,000 lb.; at a temperature of 1500 deg. F., where iron and steel are practically useless, it has a tensile strength of about 25,000 lb.

P. G. & E. Co. Furnishes 40 Per Cent of State's Needs

SINCE 1914, Pacific Gas & Electric Co. has shown a steady growth in output of electric energy, which, if continued at the same rate until 1930, will mean a demand double that of today. There is every reason to believe that with the further development of California this can be accomplished.

At this time, according to recent statements, the Pacific Gas & Electric Co. is caring for 40 per cent of the total electric and gas business of the state, supplied to more than half its population. It is now the second largest hydroelectric utility in the country, and serves consumers utilizing its service for widely diversified purposes. The natural advantages the company enjoys were fully brought out by the favorable earnings for 1921, a year of nation-wide business depression. Increases were shown in gross revenue by every branch of the company's business excepting in sales of power to agricultural, mining and manufacturing industries.

The company's management has originated several new departments which have greatly increased its business and improved its relations with the public. Its laboratories have popularized many new electric and gas appliances, including thermostatic gas ranges, gas torches, bakery ovens, gas burning steam, hot water and hot air heaters, etc.

Pacific Gas & Electric Co. is also encouraging the use of electricity on the farm, and its rural business is increasing at an encouraging rate. Eighty-three per cent of the irrigation projects of California depend on The Pacific Gas & Electric Co. for pumping power. In addition, over 3,000,000,000 gal. of water were sold for irrigation purposes during 1921 in Placer, Nevada and Butte counties.

With the many demands on the company for its service, work is being pushed to increase power output by the construction of new hydroelectric plants. Eventually the present steam plants will become only auxiliary units. During the past year about 64 per cent of the power developed was generated by water and 36 per cent by steam. A saving 1,170,203 bbl. of fuel oil over 1920 was accomplished through increased operation of hydraulic generators.

Builders Detail High Cost of Power Job

QUICKSAND, underground rivers and swelling ground were given as the outstanding causes for the high cost of the Caribou hydroelectric project of the Great Western Power Co. by S. L. Shuffleton, manager for Stone & Webster, contractors, at a hearing before Railroad Commissioner Chester H. Rowell recently.

Since the beginning of the general rate case, which involves the Great Western Power Co., Assistant City Attorney John J. Dailey and Judge F. S. Brittain, counsel for the California Federated Farm Bureaus, have sought to ascertain the cause for the unprecedented cost of the Caribou project.

Chaffe Hall, counsel for the utility, placed Shuffleton on the witness stand and the latter told of obstacles in the construction of the various tunnels, which were regarded as unprecedented.

Tunnel No. 1, which was constructed at a cost of $4,104,916, or $366 per ft., involved boring through approximately 1000 ft. of quicksand and pumping more than 13,000,000 gal. of water daily.

Shuffleton testified that the water pumped from the tunnel was sufficient to supply a city of 130,000 persons. This tunnel followed an old river bed of gold bearing sand, and was capped with lava. Two thousand horsepower pumps were employed day and night to prevent the boring from filling with water.

Tunnel No. 2, cost $2,207,510, or $240 per ft., and conditions similar to those encountered in Tunnel No. 1 were encountered. Tunnel No. 3, which is a pressure tunnel, was constructed at a cost of $1,289,965.

There is expected to be no controversy over the cost of the construction of the transmission lines from the Caribou power plant to the Valona substation near Oakland. This line has a length of 184 mi. and its cost was placed at $2,550,667 by the Great Western Power Co.

Consolidated Company Orders Switching Equipment

A CONTRACT for switching equipment amounting to approximately $250,000, the first order ever given for the vertical isolated phase arrangement of circuit breakers, has recently been placed by the Consolidated Gas, Electric Light & Power Co., of Baltimore. The equipment, which was ordered from the Westinghouse Electric & Manufacturing Co., is to be installed in the new switch house of the West Port Station of the

Consolidated Co. The contract covers oil circuit breakers, gang operated disconnecting switches, interlocks, reactors, etc. The circuit breakers are for the generators, bus ties and the feeders, the interrupting capacities being 40,000 and 30,000 arc amperes at 15,000 v.

The gang operated disconnecting switch mechanisms are interlocked with the breakers. The disconnecting switches and operating shafts are interlocked with the cell doors so that access to the breaker and disconnecting switch compartments cannot be had by the attendant unless the breakers and disconnecting switches are open. The scheme of operation employed by the Consolidated Gas, Electric Light & Power Co. is somewhat different from that used by other operating companies, necessitating the use of feeder selector disconnecting switches. The feeder selector disconnecting switches have electrical interlocks on the operating mechanisms so that they cannot be opened when the circuit is alive and there is also an interlock between the operating shaft and the reactor and disconnecting switch compartment so that the attendant cannot have access to the compartment until the disconnecting switches are open.

Portage Canal to be Used for Power Purposes

WORK on the new power project of the Interstate Public Service Company of Connersville, Ind., which contemplates the conversion to power purposes of an old abandoned portage canal in Connersville, was recently begun.

The plans call for the dredging of the canal and the building of a dam and a small hydroelectric generating station at each of the five locks in the canal, which are situated within a distance of approximately 4 mi.

The generating equipment for these stations consists of five waterwheel generators with direct connected exciters. One of the generators has a capacity of 500 kv.a., another 312 kv.a., a third of 250 kv.a., and the remaining two of 150 kv.a. each. Four of the stations will be automatically controlled from the central plant, which will be connected with an existing steam plant and will be manually operated.

A supervisory control system from the central plant over a single pair of telephone wires is also planned. By an automatic, selective, audible, signalling arrangement, an operator in the central plant will be enabled to ascertain the head of water available and the gate opening at each plant. Should any station be shut down in any other than the normal sequence of operations as might occur in case of overheated bearings, overload or the operation of any of the protective devices, a high pitched warning signal will be sounded at the central station from a loud speaking receiver. Manipulation of the dial of an ordinary automatic telephone will locate for the operator the station out of operation and enable him to determine the cause of the trouble.

News Notes

LANCASTER, one of the great industrial towns of east central Pennsylvania, is to have a very ambitious electrical show Oct. 18, 19, 20 and 21 in the Auditorium on the third floor of the Arcade Garage. The show is to be under the auspices of the Lancaster Electric Contractors Association. Their announcement says that the Lancaster show will be the equal of any metropolitan show, and that they will present novel lighting effects, unusual applications of power, and other features that have not even been utilized in New York. The Edison Electric Co. has joined with the contractors in sponsoring the show.

FOR USE in connection with its Annual Roll Call for members, the American Red Cross has prepared three posters, as illustrated. The Roll Call extends from Nov. 11 to 30 and those who are willing to help by placing posters in their plants can secure copies by writing Headquarters of American Red Cross, Washington, D. C.

A STATEMENT published Sept. 8, at York, Pa., indicates that well laid plans are under way to finance the purchase of the water-power, electric light plant and

distributing system of the York Haven Water & Power Co. on the Susquehanna River, at York Haven, by the Metropolitan Edison Co. of Reading. These plans, it is understood, were ratified by the stockholders of the smaller plant. The Metropolitan company, with its plant at Reading will, on completion of its transmission lines, have a system extending from Dover, N. J., on the east to the west of Easton, in west central Pennsylvania. The estimated cost of the extensions, etc., at Reading is $1,000,000; while the high tension transmission lines from Easton to Dover, and Annville to York Haven will take another $500,000. Another line is planned to connect Reading with a new power plant at Pine Grove. The Reading-Ringing Rocks transmission system is being strengthened to 7500 kw. capacity between West Reading and the Cromby Station of the Philadelphia Suburban Gas & Electric Co., where a new 10,000-kw. turbine is being installed. Between 45,000 and 50,000 kw. can then be delivered by line along Reading right of way from Reading to Easton, line now being under construction, connecting Metropolitan Edison company line, northeast of Boyerstown, running through Berks, Montgomery, Bucks and York counties.

The new lines are double circuits, strung on steel towers, with voltage high enough to deliver the 20,000 kw. the distance of 60 mi. between West Reading and Easton. A recent addition of 10,000-kw. turbine to the Easton plant is helpful in handling the new extensions, officials of the company say.

ECONOMY FUSE & MFG. CO. has removed its Detroit, Michigan, sales office from the Majestic Building to 1528 First National Bank Building.

JOHN S. BLEECKER, formerly of Columbus, Ga., has been transferred from his managerial duties at New Orleans with the Stone & Webster Co., to become general manager at Springfield, Ohio, of the Indiana, Columbus & Eastern Traction Co.

ELLIOTT CO. of Pittsburgh, Pa., announces the opening of a new district sales office in Atlanta, Ga., in the Hass-Howell Building. The Atlanta office makes the twelfth district sales office established by this company and is in charge of H. A. Hoffmann, formerly with Elliott Co. in the Philadelphia office.

THE LYNCHBURG TRACTION & POWER CO. is to spend $125,000 at the Elgin station on Blackwater Creek, according to Bryant White, general superintendent of plants and construction. A new turbine will double existing capacity. A 150-ft. radial brick stack and addition to building 50 ft. beyond present walls are included in plans.

AN ADDITIONAL 2000-hp. turbine installed at the plant of the Charlotteville & Albemarle Railway Co., on Ravanna River, Va., will double their capacity. They supply current to Rotherwell Apple Storage plant, as well as 100 hp. amounts to signal and train control systems of the Southern Railway, Chesapeake & Ohio, and other wholesale consumers, including the University of Virginia.

FEARING THAT projected dam construction by Pennsylvania and Maryland power companies at Middletown on the Susquehanna may damage river front steps at Harrisburg, members of the local Taxpayers League asked the city council to find what effect on the height of river would result therefrom. They empowered City Solicitor Seger to investigate through the Public Service Commission and power companies, and others, and report his findings to the council, who could then reassure citizens as to possible floods on their river front. These dams would largely supply to Harrisburg, West Shore and other neighboring communities and the City of Baltimore new hydroelectric power. The Susquehanna Power Co. is the firm delivering the high-tension long-distance transmission line power into Baltimore, thus giving it the name throughout the east of "The Electric City." At present their service is from the dam at McCall's Ferry, but it has long been known that they are pulling the wires for further and newer sources of hydraulic power on the Susquehanna. Should plans go through later on, they may be linked with the Baltimore city water works and McCalls Ferry and other places up river may furnish drinking water to Baltimore.

THE DIRECTORS of the Quaker City Rubber Co., of Philadelphia, recently elected James M. Dixon and Norman E. Oliver as directors of the company. Mr. Oliver was also elected as one of the vice-presidents. Mr. Dixon is president of the Tobacco Products Co., and director of several other large corporations in the United States. Mr. Oliver was late vice-president of the B. F. Goodrich Co., and has had long experience and a good record of achievements in the rubber business.

THE MCCLAVE-BROOKS CO., Scranton, Pa., announces the following appointment: B. S. Briggs, 1736 South 18th St., Omaha, as representative in Nebraska and Western Iowa. On Oct. 1 C. H. Thomas, now attached to the Chicago office, will assume his duties as manager of the Detroit branch office which is being opened to take over the sales work formerly handled by A. H. Sloan & Co., Inc., of that city. Joseph B. Noros, 834 Connell Building, Scranton, has been appointed special representative in the anthracite field and in Eastern Pennsylvania.

A RECENT application to the Federal Power Commission was from the Alabama Power Co. for a hydroelectric development on the Tallapoosa River. The application calls for construction of four dams, with a capacity of 140,000 hp., costing them some $40,000,000. The company expects its Michell dam project on the Coosa River to be producing 120,000 hp. by Jan. 1, and incidentally reducing the annual periodical damages from unchecked floods.

The neighboring Piedmont, Carolina, section has between 1,600,000 and 2,000,000 of undeveloped horsepower. Of some one thousand textile mills in this section very few are affected by the coal strike. Three hundred and forty-three plants use hydroelectric power, exclusively; 295 use steam power only; and 262 use both electric and steam power.

THE CONNECTICUT Light & Power Co. has started excavating for foundations for one of the largest power projects in the state at Devon, near Danbury, which, with equipment and transmission lines, will cost approximately $4,000,000. The company recently purchased a tract containing 55 acres upon which the new development will take place. Current will be generated at the Housatonic River. The new plant will generate electricity for power and lighting throughout the Naugatuck Valley and will also give an auxiliary supply to New Britain and Bristol.